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THE IRON TRADE REVIEW

VOLUME XXX. CLEVELAND, O. OCTOBER 28, 1897 CHICAGO, ILL. NUMBER 43

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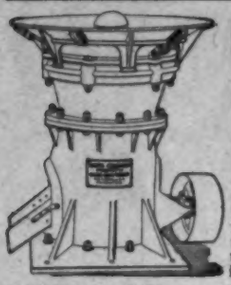

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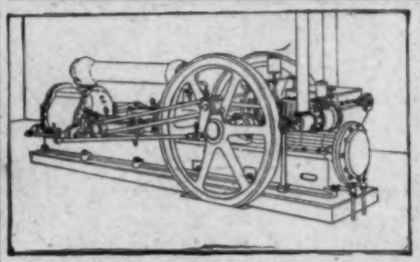

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THE IRON TRADE REVIEW

VOLUME XXX. CLEVELAND, O. OCTOBER 28, 1897. CHICAGO, ILL. NUMBER 43

THE WEEK IN IRON CIRCLES.

THE MARKET AT LARGE.

So far as new business in iron and steel is concerned the past week has probably been the quietest in two months. In pig iron no change in prices is made, nor is any change reckoned as immediately probable. In a few finished products the situation is easier, with some offerings at a shade below the basis recently prevailing. This statement does not apply, however, to the products of plants starting with billets or sheet bars—here the oversold condition of Bessemer steel mills and consequent delayed deliveries are still controlling factors, and the scarcity of primary material makes difficult the delivery of secondary products, prices meantime holding firm. Sheet, skelp and pipe mills in particular are complaining of non-deliveries, material in some cases being six weeks over-due. The halt in new buying is generally recognized, and is just as generally accompanied by the feeling that it has no cause for apprehension. Legitimate consumption, it is argued, has governed the buying thus far, and as long as the country is using up material at the rate of the past six weeks there is inherent strength in the situation. There is a unanimity in the belief that the revival has gone on in the way best calculated to ensure permanence and steadiness, that indicates strong confidence on both buying and selling sides. If sellers feel that they can afford to wait because furnaces and many mills have business that will occupy them to the end of the year, buyers on the other hand are so generally supplied for the balance of the year, and have seen prices make such moderate advances under strong buying movements, that they are not moved by fear that the market will get away while they wait. One deal of note was made in Bessemer pig iron, the past week, a Pittsburg producer taking 35,000 tons for 1898 delivery. This bears out what has been referred to before—that leading Pittsburg steel works have been using up more iron than their furnaces have made. The market remains $10.50, Pittsburg delivery and $9.85, valley furnace, for 1897 iron, the old differential between the valley and Pittsburg price being again, for the time being, equal to the freight. Gray forge remains firm at $9.65 to $9.75, Pittsburg. Foundry irons have been steady and quiet throughout the month. Northern irons are again generally on a basis that practically equalizes the freight from Southern furnaces, with Southern No. 2 at $7.50, Birmingham, and thus there is little or no wavering. Stocks at furnaces are decreasing, and the expectation is that Nov. 1, in spite of an increase in production, will show a moderate reduction in stocks, though not so much as the 170,000 tons of September. Foreign advices are that the export outlook is still good. Prices in England and Scotland are firm again, after a slight speculative reaction, and this in the face of the falling off in demand from the engineering trades. The offering of Southern iron warrants in the Eastern markets at concessions has had little influence on the situation. Warrant yard reports show that 10,300 tons of iron were withdrawn in the 10 days preceding Oct. 20 and 4,500 tons put in yard. The withdrawals are more than usual, but are not enough yet to be a factor. In finished material, bars are weaker at Pittsburg, and structural and plate mills are not so fully employed as in the early portion of the month. The approach of the quiet time of year is noticed, but much store is set on the prospects in many lines for a large demand early in the new year.

THE CLEVELAND DISTRICT.

The iron ore market shows all signs of the approaching end of the season. There are a few inquiries for low phosphorus ores, and it is reported that one buyer is after a round block of ore, with little prospect that, even by shopping around, the order can be taken care of. The October ore movement has been of good volume and the Nov. 1 statement is expected to show a total close up to 11,000,000 tons. The lake freight situation has not brought the hoped-for compensation to vessel men. Rates have remained stationary through October and in the past week very little business has been offered from Escanaba and the head of Lake Superior, though tonnage is now being sought for Marquette ore. Ore shippers in general have little more ore to come down, and the November freight market will be supported almost entirely by grain and coal.

Pig Iron. Pittsburg has monopolized the activity in Bessemer iron the past week. Purchases of 35,000 tons for delivery this year, to a Pittsburg district steel works had little interest for valley furnaces apart from the speculative iron involved, on which deliveries were being pressed by the makers. The price is said to have been a shade under $10.50, Pittsburg. One lot of Bessemer is said to have sold at $9.75, valley furnace, but $9.85 for this year is the general minimum and $10.25 for 1898 delivery. The coke situation is still dubious. The water scarcity and the car scarcity continue and the influence of the former on next year's prices points to a higher price than has been thought likely thus far. The leading interest is reported to have renewed for 1898, the arrangement of this year for taking all the output of another Connellsville company. The price talked of in connection with these arrangements is taken to point to $1.75 as a minimum for furnace coke, with a higher figure possible. Furnacemen have no disposition as yet to make sales for 1898 delivery. Foundry irons are firm at former prices, most valley interests holding to $10 for No. 2 and $10.50 for No. 1 at furnace as minimum. We quote Cleveland deliveries:

Bessemer	10 50	Valley Scotch No. 1	$11 15@11 40
No. 1 Strong Foundry	11 15@11 25	Valley Scotch No. 2	10 65@10 90
No. 2 Strong Foundry	10 65@10 75	Gray Forge	9 65@ 9 90
No. 3 Foundry	10 00@10 25	Lake Superior Charcoal	12 25@12 50

Finished Material. The outcome of the competition for the material for the Rockefeller vessels is the placing of plates and shapes—a total of more than 7,500 tons—with Pittsburg on terms which are not available. A quieter market in bars, iron and steel, is reported and the price has receded a trifle, present quotations being 1.05c to 1.07½c, Cleveland. Structural business is of light volume, and plates are quiet, with 1.10c, Cleveland, quoted on heavier, and 1.15c, Cleveland on 3-16 and ¼-inch. Sheets are firmer, and 2.15c to 2.20c, Cleveland, has been quoted on No. 28 in small lots. The quotation on relaying rails is $15 to $15.50. Old iron rails are $14 to $14.50; old steel rails six feet and under, $10.50; No. 1 railroad wrought scrap, $11.50 to $11.75.

CHICAGO.

OFFICE OF *The Iron Trade Review*,
1142 MONADNOCK BLOCK, Oct. 27.

The week has been quiet with no very large sales. The demand for material of all kinds is not so large as it has been for the past several weeks, and business in the next few weeks is not expected to be as heavy as for the last month. This is largely because the mills and furnaces have filled their order books for the balance of the year, but is also because the consumers have filled their requirements or nearly so, for the same time. The fact that stocks of all kinds are very light, both in the hands of makers and consumers, and that deliveries are being made as fast as possible, induces the belief that with the opening of the new year a very heavy demand for all classes of material will be had.

PIG IRON.—Business was light last week, neither the furnaces nor buyers appearing to want to do any considerable trading. The former have well filled order books, and are not anxious to take any more business in large lots for delivery the balance of this year, and buyers appear to have satisfied their requirements for the time being. The market is very firm although nothing is heard of further advances. The largest producer in the South is reported to have the smallest stocks that it has had for many years past, and is shipping iron as fast as it can be made. All the other producers, both North and South, have very light stocks, and are making shipments as fast as they can. This is the strongest factor in the present situation, and it would ordinarily take a comparatively small demand to send prices higher than they are at present. Quotations are unchanged from last week:

Lake Sup. Charcoal	$12 50@13 00	South'n Coke No. 3	$10 35@10 60
Local Coke Fdy. No. 1	11 50@12 00	Southern No. 1 Soft	11 00@11 25
Local Coke Fdy. No. 2	11 00@11 50	Southern No. 2 Soft	10 60@10 85
Local Coke Fdy. No. 3	10 50@11 00	South'n Silveries	11 25@11 50
Local Scotch Fdy. No. 1	11 50@12 00	Jackson Co. Silveries	12 50@14 50
Local Scotch Fdy. No. 2	11 00@11 50	Ohio Strong Softeners	12 00@12 25
Local Scotch Fdy. No. 3	10 50@11 00	Alabama Car Wheel	16 00@17 00
South'n Coke No. 1	11 00@11 25	Malleable Bessemer	10 75@11 00
South'n Coke No. 2	10 60@10 85	Coke Bessemer	11 50@12 00

BARS.—Sales were not so large last week, but still included several good orders, and there is considerable demand for all kinds of bars. The market is very firm, and prices are made at 1.15c to 1.20c for common iron, 1.20c to 1.25c for guaranteed iron, and 1.20c to 1.25c for soft steel bars from strictly billet stock.

RAILS AND TRACK SUPPLIES.—Nothing was done in this market except in small lots. There is a good demand for light sections from street railroad work. Prices are as follows: Rails, $20.50 to $22 50, according to specifications; steel splice bars, 1.20c to 1.30c; track bolts, with square nuts, 1.80c to 1.90c; hexagon nuts, 1.90c to 2c; spikes, 1.60c to 1.65c.

BILLETS AND RODS.—Business has been very light, so far as the local mills are concerned. Some buying was done from Eastern mills. Prices are unchanged and are nominal at $18 to $18.50 for billets and $25 to $25.50 for rods.

STRUCTURAL MATERIAL.—No large contracts were let. The contract for two bridges on the Drainage Canal, taking about 1,600 tons of material, will be let early next month. The third bridge, calling for about 3,500 tons, will not come up until some time in December. The Gates Iron Works is building a large addition to its plant which will take about 400 tons of material. Prices on plates of all kinds have been advanced $2 a ton in the week. Quotations are made as follows: Beams, 15-inch and under, 1.30c to 1.35c; 18, 20 and 24-inch, 1.40c to 1.45c; angles, 1.20c to 1.25c; plates, 1.30c to 1.35c; tees, 1.30c to 1.40c. Small lots from stock are quoted at one-quarter to one-half cent higher.

PLATES.—Several good sized orders were closed last week, but the bulk of the business was in small lots. There is a good demand for both large and small lots, and business is expected to be good for the next month, at least. Quotations have been revised as follows: Tank steel, 1.30c to 1.35c; flange steel, 1.40c to 1.45c; fire-box steel, 1.85c to 5c.

SHEETS.—Some business of fair size was closed. The greater part of the sales were in small lots, however, and the demand for large lots is hardly as brisk as it was two or three weeks ago. The market is very firm and several mills are asking higher prices than those we give. Quotations are made at 2.20c to 2.25c for No. 27 black, and 80 and 5 to 80 and 2½ per cent discount for galvanized.

MERCHANT STEEL.—The mills are still not anxious for business, and are not pushing for sales. The demand is not so large as it has been, as buyers seem to have satisfied their wants for the time. Quotations are firm, and are frequently made higher than the prices we give: Open-hearth spring, tire and machinery steel, 1.65c to 1.75c; smooth finished machinery steel, 1.60c to 1.65c; smooth finished tire, 1.45c to 1.50c; tool steel, 5.50c to 7.50c; specials, 11c and upwards.

SCRAP.—The demand is not so heavy as it was a week ago, although several sales of quite large tonnage were closed last week. Prices are inclined to be higher in some instances. Dealer's selling prices are as follows:

Old iron rails, gross	$12 75@$13 25	Axles, net	$14 00@$14 25
Old steel rails, long, gr.	10 50@ 11 00	Cast borings, net	4 00@ 4 25
Old steel rails, short	9 00@ 9 50	Wrought turnings, net	5 50@ 6 00
Old wheels, gross	11 00@ 11 25	Axle turnings, net	7 25@ 7 50
Railroad forge, net	11 75@ 12 25	Mixed steel, gross	7 00
Dealer's forge, net	10 00@ 10 50	Stove plates, net	6 00@ 6 25
No. 1 mill, net	8 00@ 8 50	Heavy melting steel, gr.	8 00@ 8 25
Heavy cast, net	7 75@ 8 25	Old iron splice b., net	13 50@ 14 00
Malleable cast, net	9 00@ 9 25		

PITTSBURG.

OFFICE OF *The Iron Trade Review*,
807 TRADESMEN'S BUILDING, Oct. 27.

The inability to get billets and sheet bars threatens serious trouble to mills rolling sheets, tin plate, skelp, and pipe. August and September deliveries are in many cases just being made and no prospect of improvement can now be seen. The proportion of new business is small. In beams, bars and plates capacities are not overtaxed and in beams more could well be taken. In pig iron a 35,000-ton purchase is the feature of the week.

PIG IRON.—One of the largest local consumers—also a producer—has taken 35,000 tons of Bessemer for delivery this year at a price not far from $10.50, Pittsburg. Included in the lot is 15,000 tons of speculative iron, remaining uncalled for, which has been offered in the last three weeks. The rest of this speculative iron was put in storage. Bessemer sales, aside from this, have been limited. For this year $10.50 Pittsburg, $9.85, valley, is asked, and $10.25 valley for early months of 1898. Reported purchases by the leading coke interest, of the outputs of other Connellsville producers for next year, together with the drought, increase the disinclination to do business in pig iron for 1898 delivery. Local furnaces are getting the bulk of business done in foundry irons, a sale of 1,500 tons of No. 2 being made at $10.50, with sales of No. 1 at $11. Gray forge is strong at $9.75, Pittsburg. Quotations are madeas follows:

Bessemer, valley	$9.85 to 10. 0
Bessemer delivered Pittsburg District	10.50
No. 1 Foundry	11.00 to 11.25
No. 2 Foundry	10.50 to 10.75
No. 3 Foundry	9.75 to 10.00
Gray Forge, Pittsburg	9.75

BILLETS.—The delays in shipments of billets and sheet bars are assuming a serious aspect. The Bellaire Steel Works, are running non-union but so far have not reached full output. The scarcity of water is causing delays on deliveries from the Mahoning Valley and accidents have retarded other mills, so that late August and early September deliveries are in some instances being made now. New business is meager. Billets are quoted at $16.50, makers' mill and $16.75 and $17 have been offered for immediate shipments. A local sale of sheet bars for St. Louis delivery was a feature of the week. The nominal quotation on this material is $18 to $18.50.

IRON AND STEEL SKELP.—The inability to get steel is felt is steel skelp, on which deliveries are badly delayed. Iron skelp deliveries are back, as well, and pipe mills are complaining. The present market is quoted as follows: Grooved iron skelp, 1.15c to 1.17c½; sheared iron skelp, 1.27½c to 1.30c; grooved steel skelp, 1.02½c to 1.05c; sheared steel skelp, 1.10c to 1.12½c.

MUCK BAR.—A sale of 1,000 tons of muck bar taken last week netted $19.75 at buyer's mill.

PLATES.—Plate orders coming in—new and on contract—fill the mills very comfortably without overtaxing them. All prices hold strong, mills quoting firmly: Bessemer and open-hearth tank, 1.10c; shell, 1.15c; flange, 1.20c. Local mills are bidding on a riveted pipe order for the Augusta, Ga., water works, which will require 1,100 tons of tank plate. The contract will be let Nov. 3.

BARS.—Steel bars are off again and are quoted at 1c, Pittsburg mill. A decided falling off in demand has come in the last two weeks easing prices somewhat. Similar conditions have been reported by bar iron mills. The mills are gener-

ally at work on old business and new orders are not numerous. Common bar iron is quoted at 1.05c valley, and best all muck bar at 1.35c, Pittsburg.

FERRO-MANGANESE.—For domestic, 80 per cent, $45.50 and $46 are quoted, depending on tonnage.

STRUCTURAL MATERIAL.—New business is becoming scarcer as the season advances and neither local mill is filled with orders. The lull of the last two weeks has been noticed but prices are not perceptibly weaker, and there has been no work of sufficient size to test the mill quotations which follow: Beams, 15 inches and under, 1.10c; 18 to 24 inches, 1.20c; tees, 1.20c; zees, 1.10c; angles, and universal plates, 1.05c.

RAILROAD AND TRACK MATERIAL.—It is now expected that the Homestead Steel Works will be making girder rails by Dec. 10. Standard sections of T rails are quoted at $20 at Bessemer. For 60-lb. relaying stock $15.50 to $15.75 is asked. On track material we quote: Iron track bolts, 1.65c to 1.70c; steel spikes, 1.45c to 1.55c; splice bars, 1.10c to 1.15c; links and pins, 1.15c to 1.20c.

SHEETS.—The inability to get sheet bars is adding to the confusion of the sheet market and deliveries on both black sheets and tin plate are far behind, with little prospect of immediate relief. Price is no consideration and offers of 2.25c for No. 28 were refused in the week because shipment could not be guaranteed. Late August and September deliveries are in some cases still pending and the scarcity of water in the Mahoning Valley now threatens further delay in delivering bars to sheet mills. Practically no new business is being done in sheets. Black sheets for tinning are quoted at $2.25.

PIPES AND TUBES.—Pipe mills are being greatly handicapped by the difficulty in getting deliveries on either iron or steel skelp. The latter is the more difficult to get now but on both, mills are behind and pipe shipments are being delayed. No trouble is found in getting discounts agreed upon which follow: Butt weld black, 72 per cent off; lap weld black, 78 per cent off; butt weld galvanized, 67 per cent off; lap weld galvanized, 70 per cent off. The second discount is 10 per cent on car load lots. Discounts on merchant boiler tubes are as follows: 2¼-inch and smaller, 72½ per cent off; 2½-inch and larger, 75 per cent off.

OLD MATERIAL.—Selling has dropped off in the last fortnight and prices on some lines have sagged slightly. Old steel rails have sold at $10.75 and old iron rails at $14 and $14.50. No. 1 wrought is firm at $12.50, net; car wheels at $11, gross, and cast scrap at $9, gross.

CINCINNATI PITHS AND PERSONALS.

Dr. M. H. Fletcher, of Cincinnati, was an interested attendant at all the sessions of the meeting. Though not a foundryman, Dr. Fletcher has an interest in foundry processes and has been a painstaking experimenter for some years with a view to improving one important feature of foundry work. His method for the manufacture of pipe cores without the use of hay rope has now been brought to such a stage of perfection that it is now a commercial factor. The process in brief consists in applying to the exterior of the pipe core-bar or barrel a pasty coating consisting of sawdust and a two per cent solution of hydrated starch. A larger bar may be used than in the ordinary process of making these cores by winding hay rope about the bar, and thus the liability to loss of pipe because of the bending of the bar is greatly reduced, especially in smaller sizes. The economy in core-making is pronounced. On a six-inch core 80 per cent of the present cost can be saved.

James A. Green, of Matthew Addy & Co., has a gift in after-dinner speaking that came in play Tuesday night at the Grand Hotel and on other occasions. Mr. Green is of the type of pig iron men who have made a distinct success in other lines before becoming a part of the iron trade.

Geo. M. Sargent, first president of the Western Foundrymen's Association, was welcomed to the meeting as one who has been from the beginning a staunch friend of the association movement among foundrymen. Much of the success of the Western Foundrymen's Association is due to his cordial co-operation at a time when members were fewer and new recruits were harder to win. Mr. Sargent is a firm believer in specializing the foundry business, looking upon this as the relief that must come from the excessive competition among all-around jobbing foundries. His own business, that of brake shoe manufacture, on which his company has concentrated, apart from its steel casting business, illustrates an evolution out of the crowded ranks of general founding.

Cincinnati, as the machine tool manufacturing center of the Middle West was naturally an attractive place for foundrymen; and the strong pig iron selling interests centered there furnished another reason for the choice.

The arrangements made for the entertainment of the visitors spoke of good committee work and of unfeigned hospitality. The burden of details came on a few, as always, but Chairman Geo. McG. Morris and his associates—D. B. Meacham, T. L. Griffith, J. D. Smith, James A. Green, Samuel Whittaker, Louis Walter, C. H. Domhoff, Lincoln Haney and Henry Gossiger—never flagged in their exertions and at the last were seemingly as loath to have their guests leave them as were the guests to go.

C. S. Bell, of Hillsboro, O., one of the vice-presidents of the American Foundrymen's Association, was a prominent figure at the meeting. One of the specialties of his foundry is church bells, which explains Mr. Bell's reference in one of the discussions, to the large amount of white iron melted at this plant. Recently Mr. Bell's company has brought out a machine especially for the Mexican trade, designed to reduce to a fibrous condition a Mexican root, from which spirits are distilled.

The Plumbago Club, as at Detroit last May, was much in evidence, and its peculiar rites were the subject of much mystery and speculation. The new ritual furnished entertainment for a select company of initiates and on-lookers Tuesday night.

Cincinnati pig iron men were on hand in force, with *suaviter in modo* as their gonfalon. The noticeable scarcity of "bad iron" letters from their foundry customers of late, and the advance in price in the past two months, are regarded by these gentlemen to have some connection, though it is not known that any of them said so in the hearing of their foundry guests of last week.

Cincinnati has made a strong bid for next year's convention of the American Foundrymen's Association, her Chamber of Commerce and local manufacturers' association taking the initiative in extending the invitation. Pittsburg foundrymen are likely to be competitors of Cincinnati, action in the same line being taken at their meeting Monday night. Cincinnati has certainly captured the good wishes of Western foundrymen. On her record as an entertainer, no city can out-vote her, but there may be reasons why the National meeting should go farther East next year.

D. B. Meacham, of Rogers, Brown & Co., whose weekly comments on the iron market have a wide reading, was conspicuous in the Cincinnati delegation.

THE suit of the Millie Iron Mining Co. against Corrigan, McKinney & Co., in which judgment for $15,000 was asked, was on trial in U. S. Court in Cleveland last week. The mining company claimed that a sale of Millie ore made in 1894 by the defendants, who were then acting as sales agents for the ore, should have brought $1 a ton more than was realized. At the same time a sale of Sunday Lake ore was made by the same firm to the same furnace company which bought the Millie ore, and the disparity in the prices on the two ores led to the suit. A number of iron ore and furnace men were called as witnesses to establish the relative values of the ores in question. Before the testimony was completed, however, the court took the case from the jury, on the ground that no cause of action had been made out by the plaintiff.

THE Seneca furnace of the Salem Iron Co., Leetonia, O., will be relined at once and three new hot blast stoves erected. The four stoves now in use will be demolished. Julian Kennedy, of Pittsburg, has the improvements in charge.

THE Haselton furnace of the Andrews Bros. Co., at Youngstown, O., is undergoing repairs which are in charge of C. J. Farrar & Co., the Pittsburg engineers. A new stove is being added.

THE IRON TRADE REVIEW

DEVOTED TO IRON AND STEEL MANUFACTURE, FOUNDRY AND MACHINERY TRADES.

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ENTERED AT THE POST OFFICE AT CLEVELAND, O., AS SECOND CLASS MATTER

OCTOBER 28, 1897.

ASSOCIATED EFFORT BY FOUNDRYMEN.

The results of gatherings like that of the Western Foundrymen's Association, at Cincinnati last week, are of two classes. In the first belong the obvious benefits of listening to and participating in discussions on practice and methods, of comparing views with others working in the same industrial lines, and of visiting works whose equipment and practice are instructive. Results of the second class are less tangible. They come from what may be called the under-current of such a meeting; from influenecs generated in the interchange of opinions as to larger phases of industrial development. The Cincinnati meeting was conspicuous both for its palpable results and for the undertone that will become more distinct with time.

True to its record, the association presented a list of papers dealing with practical problems—in this case they related to the cupola and the molding floor. The discussion on the comparative fusibility of metals involves an ultimate approach to greater certainty in cupola operations and closer regulation of fuel consumption. The paper on the value of physical tests compared with the regular use of chemical analysis, recalls some recent history in foundry disputation; yet it must be said that the question is yet a very live one, and one on which the last word has by no means been said. The third paper, on molding sand, appealed to every practical foundryman present, and the discussion was valuable—not least for the unwritten testimony given at several stages, to the value of the chemist's light on the problems of the sand-heap. In this connection reference may be appropriately made to the thoroughly practical and experimental lines on which the Western Foundrymen's Association has carried on its work. No other foundrymen's association has made so large nor so important a contribution to foundry literature. No other has brought out so much that is valuable on administrative questions, as instanced in its papers and discussions on methods of keeping costs, and its preparation of a system of apprenticeship and forms of indenture for the various classes of molders. This latter received prompt recognition from the American Foundrymen's Association, which adopted it entire and recommended it to the foundrymen of the country as a means of improving the standard and increasing the proportion of skilled molders. We refer thus to this side of the association's work, to commend it to foundrymen of the West and the Central West for the success it has had in the past four years and to suggest that its further prosperity lies in following along the same lines of effort. One question that belongs in the category referred to, is the much mooted, but far from settled, one as to sizes and forms of test bars. Why should not the Western Foundrymen's Asociation move in this matter with a view to securing action that will express the consensus of American foundrymen, and bring them in co-operation with the International Society for the establishment of testing standards? It is none too soon to start, if American foundrymen are to have a hand in the international action which it is hoped will be taken at Paris in 1900.

The second set of results of the Cincinnati meeting deserves a word. The interchange of sentiment among those present showed what was also apparent at the National meeting at Detroit last May—a general appreciation of the fact that all industry to-day is in a state of flux, of evolution. President Schumann emphasized the new conditions in his address at Detroit—small margins, concentration of operations, the development of export trade, a growing sense of the need of better co-operation between capital and labor. Martin Fox, president of the Iron Molders' Union, speaking at Detroit, referred to these same conditions with a view to making sentiment for an eight-hour day, with eight hours' pay. At Cincinnati the policy of closer co-operation, rather than destructive competition, found an advocate in Wm. H. Pfahler, of Philadelphia, who journeyed from his home to lay before the Western foundrymen a plan for associating together, outside the lines of technical societies, so that through greater uniformity in foundry wages in different parts of the country, retaliatory and predatory competition might be avoided, with its inevitable accompaniment of wage reductions and strikes, and the relations of employer and employed put where they would be, but for the active efforts of demagogues and political intriguers to maintain war between capital and labor. Lazard Kahn, of Hamilton, O., who like Mr. Pfahler is a member of the very successful National Stove Manufacturers' Association, sounded a like note at the dinner given by Cincinnati foundrymen, in a thought-provoking speech when he referred to the waning of individualism and the waxing of co-operation. Associated effort, he maintained, will be more and more the rule. While in the days of large profits manufacturers were indifferent on this subject, four years of adversity, and the rapid drift into new conditions have forced them to think of new expedients.

Space will not permit of more detailed reference to the two sets of impressions made by the Cincinnati foundrymen's meeting. To be sure, it was attended by but a fraction of the foundrymen of the country, but the representation was sufficient to warrant the generalization about the foundry trade of the future which, no doubt, the reader has already made. More and more is success in the foundry to be based on the use of every economy that technical research can command; yet united rather than isolated effort must be depended on to work out the problems of practice. And the broader questions, those that grow out of the relation of employer and employe, are likewise to reach a more satisfactory solution under combined, co-operative action. In this latter field, we believe, the National organization, the American Foundrymen's Association, will find the largest room for its endeavors.

ECHOES OF THE CINCINNATI CONVENTION.

There have been two larger gatherings of the foundrymen of the United States—at Philadelphia in 1896 and at Detroit last May—but none that in spirit or in promise for the enlargement of association work, exceeded that at Cincinnati last week. In other columns is given a transcript of what was said and done at this Fall meeting of the Western Foundrymen's Association. There remains, however, the recording of some impressions and the reflection of some of the side lights.

First of all, the foundrymen of the Central and Farther West found that Cincinnati filled their idea of a convention city. The inordinate heat that has visited the entire country this fall was tempered to proper autumn moderation. There were everywhere visible the evidences of the "better times" which kept many members from coming, and lent to the sojourn of some who made the pilgrimage, an uneasiness about the burden of business they had thrown upon their stay-at-home associates, that was quite a new sensation. There was life in the down-town streets of the city; and as the visitors swept in trolley cars across the hills overlooking the river section and that next higher plane that lies between river and highlands, or were carried through the nearer suburbs on their steam-car excursion, they saw abundant proof that industrial as well as commercial life had felt a quickening.

manufacturers mean that a committal to the employment of none but union men. As for his own works, speaking as a member of the National Stove Manufacturer's Association, the question of membership or non-membership in a union was never asked. After years spent in bitterly opposing labor organizations he had found the policy of conciliation and of dealing with employes as man with man, to guarantee immunity from strikes. And where employers united in following such a policy, wages were maintained with a resulting tendency to maintain prices of products. The practice had been, under the old way, and was yet to a large extent, to cut prices and get business in competitors' fields and then cut wages in order to save a loss. The better way, as defense association methods had demonstrated, was to bring the wages in the shops of such competitors up to the standard, and then the slaughtering of the market would cease.

Mr. Pfahler referred to the community of interest between employer and employe, and asserted that in spite of the demagogue and the politician, 60 per cent of employes in the average manufacturing establishment had a downright desire to further the interests of their employer, recognizing the fact that a hard-working, industrious, thinking employer meant more work for them, and taking no stock in the idea generally advanced by agitators that the employes did all the work while proprietors were supported in idleness.

Mr. Pfahler desired an expression from those present as to the desirability of going further with the movement of the

WESTERN FOUNDRYMEN'S CINCINNATI MEETING.—FROM GROUP PHOTOGRAPH TAKEN AT NILES TOOL WORKS, HAMILTON, OHIO.

There are two classes of attendants at such gatherings—those whose chief interest is in the discussion of practice and who value the meetings for the new light thrown on the problems of the foundry—and those to whom the social features appeal more strongly. Both were abundantly satisfied with what was given them at Cincinnati. The meeting certainly gave emphatic demonstration of the value of such associations, and the practical question that rose in the minds of those who have attended foundrymen's meetings at Philadelphia, Detroit, Chicago and Milwaukee was on what lines and by what plan of organization will the work be pushed in the future?

A Movement for Closer Co-operation.

The question asked above was answered in part by a meeting held Tuesday noon, independent of the Western Foundrymen's Association, but to which all in attendance were invited. John A. Penton, secretary of the American Foundrymen's Association, was chosen to preside, and Wm. H. Pfahler, of Philadelphia, chairman of the American Foundrymen's Association's committee on defense association presented in an admirable address reasons for closer relations between the foundry firms of the country. He explained that the movement for the organization of a defense association is not to antagonize labor, organized or otherwise, but rather to come to a better understanding with employes. Neither does the formation of a defense association among

American Foundrymen's Association for a defense organization. He said that he expected to meet Eastern foundrymen at New York at an early date and wanted to be able to make some report as to the sentiment of foundrymen in the West. A motion was carried unanimously that those present endorse the action thus far taken by the defense association committee and favor the plan of organization as far as outlined.

The Trip to the Niles Tool Works.

The excursion of Wednesday afternoon to the Niles Tool Works, at Hamilton, 25 miles up on the C. H. & D Road, was a feature of the meeting that will long be remembered pleasantly by all who went. Starting at 1 o'clock, a 45-minutes' run brought the party, which occupied two coaches, to the shop sidings at Hamilton, and a few moments later the group picture reproduced herewith was taken, the visitors gathering in front of the main building. Under escort of Col. R. C. McKinney, treasurer and general manager of the company, the guests were conducted to the office rooms in the second story, where a choice luncheon was served, with liberal accompaniments of frozen punch and champagne. The health of the officers of the company was toasted and at the luncheon and later in the afternoon before the return trip, speeches of eulogy and hearty thanks were made by various members of the party.

The afternoon was spent in the works, which were a revela-

tion to many of the visitors. At present 700 men are employed and skilled molders and machinists are to be added, bringing the total up to 800, the full complement of the plant. With this increase night work will be started.

The shops are of mammoth proportions, nine acres being taken up with buildings and yards, the latter with the various additions made from time to time, being now quite circumscribed. In the machine shops some monster tools were under way, one being a 60-ton drilling, boring and milling machine designed for ship-yard work. Farther along a 10-foot planer, with automatic feed requiring no change of belt, was at work on the bed of a great lathe for locomotive work. Near by was being operated the planer which was conspicuous in the company's exhibit at the World's Fair—a huge affair, 10 by 12 by 31 feet. A piece of work under way was a 24-ft. bed for a boring mill.

Probably the most interesting feature of the shops' operations was the gun carriage work, the company having a contract to deliver to the Government 14 Buffington and Crozier disappearing carriages for 10-inch guns. The building up of the guns from the forged steel breech, the rifle and the great steel bands which are shrunk upon it, is also done here under the supervision of an expert from the Krupp works. There are seven pieces to each gun, the whole weighing about 30 tons. The iron castings for the carriage, which are made in the foundry of the Niles Tool Works, the largest weighing

DISAPPEARING GUN AS MOUNTED AT NILES TOOL WORKS, HAMILTON, O.

seven tons, consist of the top carriage cylinders, traverse circles, foundation rings and fittings. The makers have been quite successful thus far in getting satisfactory metal for this important work by the use of the cupola for melting, though in some establishments reverberatory furnaces alone are employed. The gun as mounted, and in firing position, is shown in the accompanying cut. By touching a lever a counterweight is released. As the latter descends the gun rises and is sustained in position over the parapet. The recoil attending the firing of the shot sends the gun back into its original retreating position, an oil cylinder cushioning the recoil. The counterweight consists of nearly 40 tons of lead ingots. The maximum range of the gun is seven miles. The projectile is 575 lbs.

The foundry operations, which include dry sand and green sand molding, were interesting to the visitors. Ample electric crane service is provided. Five large cranes are in use in foundry and machine shop, those in the latter being of the original Morgan pattern, with square shaft drive. It is noteworthy that these old-type traveling cranes have been in use for many years, with scarcely an expenditure for repairs.

The physical and chemical laboratories of the plant received their share of attention, in view of the discussions on the value of such equipment in the foundry. The testing machine is of 50,000 lbs. capacity. A bar pulled during the visit, broke at 20,000 lbs., with a clean, close fracture. The iron used in the original mixture was Belfont and DeBardeleben.

The vote of thanks given the Niles Tool Works Co. on the return to the offices, where refreshments and chat were the order till train time, was given with a will. It was certainly one of the pleasantest and most profitable shop trips ever taken by any similar association.

THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The fall meeting of the Western Foundrymen's Association was held in Cincinnati, Oct. 18, 19 and 20, 1897, at the Grand Hotel. The opening session was called to order at 10 A. M., Monday, Oct. 18, by President C. A. Sercomb. The register of those in attendance showed the following names:

Cincinnati.—Geo. McG. Morris and John B. Morris, John B. Morris Foundry Co.; T. L. Griffith, John Hill, F. S. Caldwell, S. Obermayer Co.; Samuel H. Whitaker and W. J. Isaacson, Dayton Coal & Iron Co.; G. P. Bassett, Jr., and S. S. Knight, Addyston Pipe & Steel Co.; Dr. M. H. Fletcher; D. B. Meacham, J. K. Pollock, A. J. Wentworth, Rogers, Brown & Co.; Henry J. Gosiger and A. G. Olderding, Eureka Foundry Co.; H. M. Lane, Chas. F. Thompson, the Lane & Bodley Co.; Chris Erhart and Harry Erhart, Chris Erhart Foundry; Clinton Truesdale, Wm. Resor & Co.; J. W. Foley, and Frank Johaningman, J. W. Foley & Co.; Geo. A. Schneider, James L. Haven, B. F. Paddack, Jas. L. Haven Co.; F. J. Spieker and Lincoln Haney, Globe Foundry Co.; J. D. Smith and Wm. T. White, J. D. Smith Foundry Supply Co.; Salmon Jones and J. H. Bromwell, West End Foundry Co.; L. F. Walter, R. C. Nicholas and B. A. Wallingford, representing Thos. A. Mack; O. D. Bryant, Crane-Breed Mfg. Co.; David Black, *Iron Molders' Journal;* Martin A. Fox, president Iron Molders' Union of North America; Jas. A. Green, Wm. R. Warner, Chas. L. Miner, W. W. Hearne, Matthew Addy & Co.; Samuel E. Hilles, W. S. Mendenhall, Samuel C. Tatum Co.; James P. Gardner, Chicago *Journal of Commerce;* Richard Ellison, C. G. Blake, C. H. Domhoff, John Sargeant and T. J. Joyce, Domhoff & Joyce Co.; J. A. Oberhelman, C. F. Thanwald & Co.; R. J. Kroger; W. J. Early, Bradford Mill Co.; F. A. Geyer, Cincinnati Milling Machine Co.; M. S. Rogers, American Laundry Machine Co.; Jno. E. Donovan, Standard Iron Split Pulley Co.; Chas. Stedman; W. L. Turner, J. R. Stewart, Bradford Mill Co.

Chicago.—Geo. M. Sargent, Sargent Co.; S. T. Johnston, Whiting Foundry Equipment Co.; A. Sorge, Jr., consulting engineer, secretary of the association; Geo. W. Cope, *Iron Age;* H. F. Frohman, S. Obermayer Co.; A. C. Hawes, Matthew Addy & Co.; H. S. Vrooman, Molding Sand & Fire Brick; Eugene W. Smith, Crane Co.; I. Springer; M. C. Armour, Rogers, Brown & Co.; B. T. Bacon, Pickands, Brown & Co.

Milwaukee.—C. A. Sercomb, Schwab & Sercomb, president of the association; B. Hoffman, B. Hoffman Mfg. Co.; E. K. Rundle, Rundle & Spence Mfg. Co.

Joliet, Ill.—W. N. Moore, Joliet Stove Co.

Vincennes, Ind.—A. Bell, Bell-Armistead Mfg. Co.

Jeffersonville, Ind.—W. D. Patton.

Quincy, Ill.—J. W. Gardner, M. D. Cheeseman, Gardner Governor Co.

Aurora, Ill.—F. M. Lyon, Burlington Route Foundry.

Indianapolis, Ind.—H. G. Byram, Cleveland Fence Co.

Detroit.—John A. Penton, *Foundry.*

Pittsburg.—Ph. Mathes, Brittain & Mathes Co.; J. S. McCormick, J. S. McCormick Co.

Sharpsville, Pa.—Thos. D. West, T. D. West Foundry Co.

Philadelphia.—Wm. H. Pfahler, Abraham Cox Stove Co.; J. H. Shaffer, Pittsburg Testing Laboratory; Andrew Hawthorne.

Newport, Ky.—Henry Schuh and Dr. A. Hembold, Newport Iron & Brass Foundry Co.

Covington, Ky.—W. T. Hollingworth and Wm. Davis, Excelsior Facing Mills.

Embreville, Tenn.—Guy R. Johnson, Embreville Iron Co., Ltd.

Powellton, W. Va.—D. T. Evans, W. F. Callender, Mt. Carbon Co., Ltd.

Springfield, O.—F. M. Bookwalter, Jas. Leffel & Co., C. A. Bauer, Warder, Bushnell & Glessner Co.; Jno. D. Sadler, Springfield Foundry Co.; C. F. McGilvery, Robbins & Myers Co.

Dayton, O.—T. P. Gaddis, Dayton Malleable Iron Co; Joseph Burns, the Brownell & Co.

Hamilton, O.—L. Kahn, F. & L. Kahn Bros.; R. C. McKinney and E. W. Hall, Niles Tool Works Co.

Hillsboro, O.—C. S. Bell, C. S. Bell & Co.

Cleveland.—J. C. Brainard, Johnston & Jennings Co.; A. I. Findley, *The Iron Trade Review.*

Painesville, O.—Henry H. Coe, Coe & Wilkes.

George McG. Morris, chairman of the local committee of arrangements, introduced Hon. Jacob H. Bromwell, member of Congress for the Second Ohio District, who made an address of welcome in a happy vein, introducing some of the foundry vernacular. Pres. Sercomb responded for the association, telling the Cincinnati people some of the characteristics of the foundrymen who had come among them for a few days, and commenting on the vast advance that had been made in foundry practice in recent years. Invitations to visit their works were then read, from the S. Obermayer Co., John B. Morris Foundry Co., J. A. Fay & Egan Co., Davis &

Egan Machine Tool Co., and Cincinnati Milling Machine Co., and one from W. McCallister, secretary, inviting the association to the Chamber of Commerce. A vote of thanks was given those extending the invitations, and they were accepted.

The secretary stated that the editing committee, who were instructed to publish the by-laws as amended, had failed so to do, but had presented a report to the effect that the by-laws had been prepared for publication and asking for further instructions in the matter. There being no objection, the chair stated that further action would be deferred until the next meeting of the association.

Applications for membership were presented from the following: H. S. Vrooman, Chicago; C. A. Truesdale, Wm. Resor Co., Cincinnati; D. H. Truesdale, Cribben, Sexton & Co., Chicago; Stedman's Foundry & Machine Works, Aurora, Ind.; Rundle & Spence Mfg. Co., Milwaukee, Wis.; J. S. McCormick Co., Pittsburg, Pa.; Johnston & Jennings Co., Cleveland; B. Hoffman Mfg. Co., Milwaukee, Wis.; Gardner Governor Co., Quincy, Ill.; Church & Getchell, Chicago; Cleaveland Fence Co., Indianapolis, Ind.; Coe & Wilkes, Painesville, O.; Bell-Armistead Mfg. Co., Vincennes, Ind.; T. S Beeson, Niles Tools Works, Hamilton, O. All the above were elected members of the association.

On motion of W. N. Moore, the secretary was instructed to obtain from the various foundries in the territory covered by the association as much information as is possible regarding their present business, and their regular capacity and to tabulate this information for the benefit of the members of the association. The secretary was also instructed to obtain this information periodically hereafter. An amendment carried, providing for a committee to start the inquiry as to an improved condition of the foundry business, among foundrymen in attendance at this meeting, this information to be extended later by letter inquiry from the secretary's office. The committee was made to consist of W. N. Moore, of Joliet, Ill.; F. M. Lyon, of Aurora, Ill., and Geo. M. Sargent, of Chicago.

Wm. H. Pfahler, of the Abram Cox Stove Co., Philadelphia, was called upon and spoke briefly, urging the cultivation of export business, and by association and co-operation cultivating better conditions at home. Martin A. Fox, president of the Iron Molders' Union, spoke briefly on being called out. C. S. Bell, of Hillsboro, O., followed. At the noon intermission the association visited the Chamber of Commerce, where the members were welcomed by the president of that body, President Sercomb responding.

Monday Afternoon.

The meeting was called to order at 2:30, President Sercomb in the chair.

A paper on "The Value of Physical Tests" was then read by S. S. Knight, of Cincinnati. It will be found elsewhere in this issue.

The secretary then read the following discussion of Mr. Knight's paper from Dr. R. G. G. Moldenke, of the McConway & Torley Co., Pittsburg: "In that portion of Mr. Knight's excellent paper on 'The Value of Physical Tests,' which relates to the comparative fusibility of hard and soft metals, he describes an occurrence that may be seen daily in every foundry, namely, that the first large body of iron that comes from the cupola is softer than the balance. Now, he claims that this is due to the softer portion of the charge coming down first. How would Mr. Knight then explain the fact that the very same thing happens when the charge consists of but one grade of iron running uniform in silicon? Is it not because the lower part of the charge in melting collects where it is no longer subject to the blast, in a comparatively short time, while the balance coming down more slowly is subject to oxidation to a continually increasing extent? In other words, with a uniform charge, aside from the first few ladles, which are always uncertain and generally hard, you could begin with soft iron, and wind up with material fit only for sash weights. I am among those who have criticized Mr. Knight in this matter, but I assure him with the best of motives, for we all thank him for bringing to light his first observation, for the valuable information which was brought out when the subject came to be studied. Mr. Knight, by his praiseworthy and conscientious effort to record facts as he sees them, can but gain in the estimation of those who beg to differ from his conclusions. Let us state the facts as we find them, and let the practical foundryman who may not agree with us, interpret them in the light of his experience, and to his best advantage."

Thos. D. West: The first part of Mr. Knight's valuable paper that I would comment upon is the statement he makes that "according to the best authorities mechanical analysis is founded upon the discovery that the shrinkage in iron varies inversely as the silicon contained therein." About a year and a half ago I read a paper before the Western Foundrymen's Association touching on that subject, in answer to a statement that Mr. Keep had claimed that the contraction of a bar would show the exact silicon in the iron. I showed that we could make a combination of the metalloids by means of sulphur, manganese and phosphorus, that would vary this contraction, so that it is no guide. It is impossible to arrive at the exact silicon contents of any iron by simply knowing the contraction of a test bar. Any founder by making a variation in the combination of his metalloids, may cause contraction that would be practically the same and if he would send the results to Mr. Keep, or any one else that makes the claims which he does, he would find himself wholly wrong in attempting to tell what the silicon contents were. The second part of Mr. Knight's paper which opens up some further fields for research, is his claim that the first tappings gave a higher silicon and in consequence softer iron. He don't tell us by what means he obtained knowledge that it is really softer iron. The practical foundrymen will all agree with me that as a rule they have little confidence in the first ladle that comes out of the cupola. I think the general experience of founders is that the first tappings of the cupola they will pour into sash weights or something of the sort, in which they are not particular about the kind of iron to be used. The conclusions that Mr. Knight has come to on that point do not agree with experience. It is to be regretted that Mr. Knight has not given us a thorough analysis of the iron. We might have discovered in it a higher sulphur, or higher manganese, or something which would have been a hardening element. I believe his claim that soft iron will melt easier than hard iron is merely suppositious.

Guy R. Johnson: While I run only a small foundry, my experiments show Mr. Knight is correct in every respect. To give you an example in point, I may say that in making chilled rolls out of cupola iron—it is a very poor way to make chilled rolls, but we have no better—we had to abandon altogether the use of the first iron because we found it too soft. We analyze all of our iron before putting it in the cupola, and take careful analysis afterwards. We find it loses much less silicon from the first of the heat than the average of the whole heat. We also lost sulphur. We use Pocohontas coke, which runs about as low in sulphur as the average coke. If we put that same iron in at the end of the heat, the sulphur went up slightly, we lost a little more silicon and we could get our chill to a dot. We were running a one-inch chill, and at the first heat got three-quarters of an inch for four days; then at the end we got an inch to one and one-eighth for six successive days. I think that bears out Mr. Knight's remark to a large extent. Another thing some of us who have been arguing on the question of shrinkage, etc., have a great deal to thank Mr. Knight for, in his researches in that line. This idea that silicon is the only metalloid that really makes any great difference is all nonsense. Really, silicon has much less effect on the resultant casting than sulphur, taken proportionately; that is to say, a casting that comes out .05 in sulphur will be a good open casting, and one with .07 to .08 will be very hard; yet the silicon in those castings generally varies less than one per cent, if you are using a mixture that you know the contents of beforehand.

Thos. D. West: It may be possible that the longer we hold iron in the cupola—the longer it is in melting—the more silicon we lose; and that no doubt would have a bearing on the conclusions Mr. Knight has given us. For all that, it doesn't alter the fact of our finding the first ladle harder. It may be true, which I agree is a matter of experience, that Mr. Johnson has got a softer iron from the chilled iron. It has been only where we went to get a softer iron first that we found that we had the first meltings hard, and, as I stated before, probably if Mr. Knight had given us complete analysis of his first meltings, we might have discovered something in them, either that the silicon was high, or that the iron con-

tained some metalloid in the latter meltings which would have had a hardening effect.

Mr. Knight: In reply to Mr. West as to analyses of the iron we are using, it would only be fair to state that we very seldom melt iron which would carry over .04 in sulphur; consequently, the addition of sulphur to our iron in the first meltings in the cupola would hardly be possible. Our irons run between .035 and .04.

Mr. West: Sulphur is a very important factor. It takes less of it to effect iron than any other metalloid. I have found that out by experience.

D. B. Meacham: We never melted any pig iron, but several years ago instituted a series of tests. We sent circulars around to the founders, asking them to make three bars, one at the first, one at the middle, and one at the last heat. We found in taking these, not knowing what they used in their mixture, that the bar which came off from the first heat broke lower, and the last was generally the highest. The supposition was that the last bar from the heat was the harder bar. We knew nothing about the softness, because we didn't analyze the silicon contents, but merely obtained the transverse strength.

Guy R. Johnson: I should like to ask Mr. West what coke he uses, and how the sulphur runs?

Mr. West: We are using Washington coke. It runs about .80 to .85.

Mr. Johnson: How much of a bed do you use?

Mr. West: We run from 60 to 70 tons. We have a certain height and we bed the coke in upon a measurement of height. I think it is 1,300 lbs. Then we have a certain amount that we put in between the charges that we measure out.

Mr. Johnson: Don't you think that that explains the hard ladle-full of iron? The first iron that comes out there is melted by the very large bed you have in. You have more coke in the bed than you put in afterwards—certainly every foundry has. You are using coke carrying .8 to .9 sulphur. The first iron comes in and absorbs most of the sulphur from that coke. That accounts for the hard iron, whereas, if you were using coke of .6 and .7 sulphur you would not find it so.

Mr. West: Where do you get coke as low as that?

Mr. Johnson: In Southwest Virginia. I have had analyses made frequently of Pocohontas cokes and some others. It rarely runs over .6.

Mr. Sorge: What is the size of your cupola, Mr. West?

Mr. Knight: I would like also to know the capacity in tons per hour.

Mr. West: The inside diameter of our cupola is 66 inches, perhaps, and we melt an average of from 60 to 70 tons. It is all Bessemer pig—no scrap. We run it down in about four and a half or five hours. We can melt it as fast as we can take care of the iron. We use a center blast. Our fuel consumption depends upon the quality of fuel somewhat. But we are melting all the way from one to 10 up to one to 14. We have got to get a very solid, good coke to melt one to 14. If we had light scrap it would come down much faster, and we would have to buy less fuel.

Mr. Knight: Mr. Meacham, what was the rough measurement of the bars you broke?

Mr. Meacham: 24 inches long, and one inch square.

W. N. Moore: Our business is the making of light castings, in which strength is not an important consideration, the shrinkage alone being about the only physical qualification with which we have to deal—shrinkage and softness. Our experience shows us that there are certain limits to which we can go, with reference to silicon and sulphur, particularly, and inside of these limits we are very safe. But when we get outside of them we fall down. We depend entirely upon the laboratory. And I think any one who will take up the matter of applying chemistry to the foundry, and follow it up for a year, say, will never feel safe without knowing afterwards just what he is doing—how much silicon it takes to make a good casting of such and such kind, or how little he can get along with; how much sulphur he can stand without liability to trouble, and also the relation of the carbon to his requirements. I don't think there is any modern foundryman who will study that without great benefit. It has been my observation, that the first iron from the cupola was hard. Whether the silicon was higher or lower I have never investigated; but I supposed there were hardly two opinions on the subject. The experiments which are given here we can't question, and it would seem as though there must be some local conditions out of the ordinary experience to account for the results.

Henry H. Coe: My observation has been, so far as I can give it practically, that the first run of iron was a little more uncertain.

Mr. C. S. Bell: It always has been a fixed idea in my mind that the first iron was uncertain, and that it was not safe to put it into castings that required any particular strength, or any particular softness; and, therefore, we use it in such castings as don't require any of these special qualities. Now, there may be many resons for this. In the first place it depends largely upon the depth of the bed of coke, and the character of coke in that bed. In the next place it depends largely upon how you fire your cupola, how much charcoal you have in the bottom, and how much you blow through the tap-hole before you close it up. We have never in all my experience sought to use the first iron as reliable iron. The first tapping may be sometimes softer than other parts of the heat. I would account for that in two ways: First, there may be more charcoal in the bottom of the cupola; next, the iron that came to the melting point first may be a better quality. I suppose that you mean when you say first iron, not the first 1,000 pounds, but the first 100 or 150 pounds. So it is largely due to the character of the metal that was melted. If we are going to make a large casting out of the first run, we would not undertake to use the first, unless we had from 1,000 to 1,500 pounds in the casting; then we would feel reasonably safe in using it. As to the question which iron is easiest melted—that is, that which requires the highest temperature—hard iron (white iron, as we term it), or gray iron, there is a vast difference between the melting of different qualities of white iron. We probably melt more white iron than any other firm in the United States, and we know that it requires a higher temperature to melt white iron taking it as it runs, than it does to melt gray iron. Probably if you were to measure the units of heat, it would be accounted for in a different way from what is ordinarily understood. For instance, you want to make a certain casting, and it may require what we would call a very hot iron to run it; but on account of the short life of the white iron you have got to have a higher temperature than you would with gray iron. You might lose that temperature after you had it running freely; therefore, you would say it required a higher heat to melt. The fact is, it simply loses its heat more quickly than does the gray iron. But there is no doubt about the fact that it requires a higher temperature and more fuel to melt a run of white iron than it does of the gray.

B. Hoffman: We find in our experience that the first iron runs always a little harder than the middle iron; and the cause of that I attribute to the bed.

E. K. Rundle: I have always noticed in melting our iron that there has been an uncertainty about the first run. We cannot always depend upon it. I have always found, though, that the iron is apt to be a little hard.

George McG. Morris: We make light and medium weight castings, and when it comes to the first part of the heat—I have reference to the first few ladles of iron taken out of the cupola—we never use it in our good castings. Iron for important castings we always take out of the middle of the heat. We have always considered that the first of the iron was not good and we don't want to use it. The first few ladles-full we use as a drier for the ladles.

Mr. Moore: There is one paragraph in the paper which interests me very much: "The facts are that shrinkage varies directly as the content of sulphur, manganese, combined carbon and titanium, and inversely as the silicon and phosphorus content." I note that free carbon is not mentioned, and I would like to ask Mr. Knight whether he does not find that the volume of free carbon present is always a considerable factor? He also mentions a metalloid that our ordinary analyses do not take into consideration, and that is titanium. I think those that have to deal with analyses in our mixtures are bothered to face conditions which our previous experience with the elements of which we have analyses—silicon, phosphorus, manganese, sulphur and carbon—does not account for. And it has often seemed to me that some other elements were present and exerting an influence of

which we had no knowledge. I would like to ask to what extent titanium or other metalloids are present in foundry iron, or liable to be present, and what their direct effect is. That is one question, and the other is with reference to the volume of carbon present, whether that does not also affect the shrinkage?

Henry Gossinger: Our first charge is 2,000 lbs. Whether we are wrong or right we certainly should not use any part of the first tap out of that first charge on castings about which we are particular. What the reasons are for it I cannot explain; I am not up in chemistry. Our experience has been that the first thousand pounds taken out of the cupola are very unreliable as far as hardness is concerned.

Lincoln Haney: Our first tap out of the cupola, first 400 to 500 pounds, we generally put in castings that will not require much finishing.

Mr. West: The complaints on the ground of castings being too hard are most numerous. We are often called up by telephone by the machine shop, and the word will come, "What is the matter with that iron? It don't plane. The machine is four times as long as it should be." So the term "uncertain" as it has been applied here, would mean according to my understanding that it was a hard iron. And I think that research on that line would bear me out in saying that it is of iron not being sufficiently soft that we mainly have complaint.

Mr. Knight: There are a few points brought forward in this discussion upon which I would like to touch briefly. The first is the melting point of various grades of iron. Some time ago our people went to considerable expense in their laboratory, in order to determine absolutely the melting point of various grades of iron. We selected one brand, which was supposed to be about as homogeneous as any brand we could possibly get—the Embreville. We took one sample of what is known as "soft iron," and another of what is known as "white iron," to determine the actual melting point; and the soft iron melted at temperature of about 100 degrees below that of the white iron. The temperatures were 1,050 degrees for the "soft iron," and 1,150 degrees for hard iron—possibly I may be a few dgrees out either way. In regard to the influence of various metalloids upon the shrinkage of iron, I would say in reply to one of the questions asked that certainly free carbon does exert a very great influence upon the shrinkage of iron; but I have taken into consideration the fact that the amount of free carbon contained in an iron is very nearly in proportion to the amount of silicon which it contains; consequently, we leave consideration of the free carbon out entirely in enumerating the various elements. In regard to titanium, I would say that it is often supposed that a very small percentage of sulphur will materially increase the shrinkage of iron. Titanium compared with sulphur is a very potent element, and I have known cases where a pig of ordinary section, which contained about .12 per cent of titanium could scarcely be broken by a sledge hammer; while without the titanium the pig could be broken very easily by a man with a hammer of like weight. One other point: That is the possibility which has been spoken of that local conditions might have affected the observations I have made. These observatins were taken in our foundry. We are melting about 300 tons a day, and we are doing that in two cupolas; consequently, you can see if there were any possibility of a technical conventionalism coming into play, it would not be so in such a case as that. Furthermore, we are using cupolas which have a capacity of about 20 to 25 or 30 tons an hour; and the hearth alone is capable of holding from 10 to 12 tons of molten iron before tapping out. So when I refer to the first tapping, I mean the first five to 10 tons which are melted.

Mr. Moore: I think that the explanation given of the conditions under which the first tap was made emphasizes the fact that there were peculiar local conditions present. The most of us don't melt 300 tons a day, nor on such a large scale; so that the facts which may prevail in an ordinary foundry, as regards the early part of the heat, might not be true, where the operations were conducted on such a large scale. I would like to re-state my question in regard to titanium. Is that a metalloid that we may come in contact with frequently in pig iron to an extent which would effect the product?

Mr. Knight: I don't suppose you will find one brand or grade of iron among a hundred free from titanium. Nearly always the titanium in pig iron will be between .04 per cent and .12 per cent. The possibility of any cases being affected by titanium is, as I have stated, quite large, on account of the extremely small percentage which it takes in order not only to increase the closeness of the grain, but also to affect the strength of the material. In regard to the conditions under which we melt, I failed to state that we use absolutely no charcoal; and as tothe conditions not being the same as in smaller plants, I don't see how there would be any material difference, because the melting heat would be about the same, only possibly we use coke which would be freer from sulphur than that which is ordinarily used. We use coke which carries about 87½ per cent of fixed carbon and a little less than .6 sulphur.

Mr. West: Mr. Knight's remarks open up a new field. If he had let us know in the start that he was tapping out so much iron, we would have started out on a different basis. He was speaking of one thing and we of another. There is no doubt on such a large tap as Mr. Knight speaks of, that he did get softer iron, for the simple reason that it melted quicker, and was first exposed to the heat of the cupola. We were all discussing the first 200 or 300 pounds which we got out; so no doubt we both were right on that point. One other point I would like to attention to is in regard to the use of titanium. Mr. Knight referred to a test of breaking pigs. I should not be guided by that. If we are to be guided by such a test as that, we are to say chemistry is of no value to us, and we would be right in judging iron by its fractures. In order to know the true value of an iron, you must remelt it.

Mr. Knight: You will understand, that in speaking of the test, I simply used that as an instance in point, because it covers a noticeable fact in our experience, noticed both in chemistry analysis and otherwise. We very frequently take contracts that call for a high transverse strain, and we use titanium to bring up the strength; and a bar which will carry .12 per cent titanium will always give us very high strength. We buy pig iron which contains titanium. Certain brands contain more than others according to our analysis.

A vote of thanks was then given to Mr. Knight for his very able and interesting paper.

The members and visitors attended a theater party at Pike's Opera House, in the evening, on the invitation of the Cincinnati contingent, and had a very enjoyable time.

Tuesday Morning.

The meeting was called to order at 10:30 A. M., President Sercomb in the chair.

On motion of S. T. Johnston, the association adopted the monogram used on the badges worn at the meeting as the official monogram, and tendered a vote of thanks to Mr. Morris, of the local committee for the idea.

The reading of Mr. Thos. D. West's paper on "Comparative Fusibility of Foundry Metals" followed, Mr. West illustrated by a blackboard sketch the form of cupola used. The paper will be found on other pages.

The secretary read the following discussion of the paper from Dr. Moldenke: "I can only add to Mr. West's able paper that open-hearth and straight draft furnace men have long bene looking for a chilled sandless metal which would enable then to reduce the amount of slag, melt quicker, and with less burning out of silicon and manganese. The advantages of melting faster in the cupola are well pointed out, with the lessening of slag, smaller increase in sulphur, and less burning out of silicon. In the case of remelting of stells or low carbon pig irons, the gradual increase of carbon up to a saturation point has since been verified in the recent pubilcations of the Iron and Steel Institute. Furthermore, the spongy nature of the material Mr. West mentions as obtained in the first steel remelt, is probably due to the absorbtion of gases allowed by the excessive reduction of the silicon and the manganese contents. The resulting material containing 1½ per cent. carbon really makes it a high carbon tool steel, though of poor quality, and this kind of steel is well known to be extremely sensitive to gases while in a melted state. The addition of steel to cast iron mixtures enhances the strength by reducing the carbon contents, thus

in a manner closing up the grain of the material. In one respect I would differ from Mr. West, however, and that is with regard to the carbon contents of melted iron. The facts as observed are correct enough, but melted iron has the property of taking up more carbon, if allowed, than can exist in it when it has solidified slowly and under ordinary conditions. Consequently, graphite is bound to separate out, and rising to the top, form 'kish.' Graphite in melted iron is therefore present only for the time being in a mechanical way, and only when the iron is above the carbon saturation point of slowly cooled iron. To demonstrate this point more fully, I would suggest to Mr. West to try the following experiments: To fill his experimental cupola to the top with coke, bring it to an intense heat, and put in some No. 2 charcoal iron. This when caught below is to be returned above several times, until a very hot well saturated iron is obtained. Now the metal is to be cast into very thin chilled bars, some while the iron is at its full heat, others as it becomes duller, the idea being to get the iron in such a gradation of temperatures, and holding its composition intact by rapid chilling, that the formation of graphite while cooling may be studied by means of the microscope. I would gladly undertake this end of the work, and present the results in the form of photographs of the actual structure.

Mr. Knight: One or two things I hardly understand with regard to the experiments which Mr. West has performed. He makes several statements which, although probably very clear, are at the same time in the nature of a surprise to the metallurgical world at large—not possibly because they are something not to be thought of as existing, but rather because no part of the work has been gone over before. He makes one assertion which was brought out yesterday, I believe, by Mr. Bell in his discussion of the paper which I presented, that in order to get a good casting from white iron, it was necessary to heat the iron to a much greater degree of fluidity, because the iron lost its life a great deal sooner than gray iron. I would like to ask Mr. West, also Mr. Bell, if they don't think the very reason why gray iron keeps its life so much longer in the ladle is because the fusing point is so much below that of white iron. You can pour it a great deal colder and produce a harder casting. In fact, a great many experiments entered into by various companies some time since, have proved as conclusively as it is possible to do it, the melting points of various brands or grades. In one experiment we performed, white iron melted at a temperature of 100 C. degrees above that of gray iron, and the analyses of the two irons very nearly correspond, the only difference certainly being in the silicon and carbon, and the variation in manganese and sulphur being quite small. There is a point Mr. West makes which seems to me a little bit obscure. He states that the longer the iron is held in the cupola the more silicon will be burned out. That goes back again to the reaction which takes place in the cupola. From the very nature of the operation, the blast coming into the tuyeres and going up through the fuel and making it incandescent, the iron must necessarily melt a number of inches above the tuyeres, usually about 18 to 20, sometimes only 14; but the fact remains, nevertheless, that the iron melted at that high temperature must go through the incandescent fuel. There is where the carbon is being absorbed. The carbon is being burned and turned to carbon dioxide. The amount of oxygen you have in the cupola is undoubtedly in excess of the amount required by carbon which is being burned. At the same time you are having carbonic oxide gas coming out as well as the carbon dioxide, so the reaction has only partly taken place and at all stages it is a reduction rather than oxidation. In that case I cannot see where any oxidation can take place. He goes on to state in one place that the carbon is changed in chilled iron. I will read a short extract: "Chilling of cast iron is caused by the rapid solidification of molten metal, preventing the chemically combined or hardening carbon which exists in it as such, from changing to graphite and thus giving a granular structure to solidified iron." He intimates further on that there is a kind of carbon in the molten iron which is not chemically combined. I remember some months ago we conducted some experiments on that point, and proved to our own satisfaction, at least, that free carbide did exist in molten iron and would exist even in a casting to a greater or less extent. When he says that the carbon is changed from the graphitic or uncombined state, whatever it may be, into the chemically combined state, it is turned into a hardening carbon, that is what I understood—I wish to ask if he means that the carbon is changed into an iron carbide of the formula which is properly most commonly taken Fe_3C, or that it is changed into what has been lately discovered and denominated as martensite. If we take into consideration the work that has lately been done in microscopy we will see that the efforts of the last few months will throw a valuable light on this paper, and especially on the last part where he is discussing the changes which take place in chilled plates. At the same time, from the fact that the retardation point is so very low, being about 600 degrees C., the carbon actually changed to martensite can be a very small part of that which actually exists. It may be that a very small portion of martensite as with titanium in iron, will so affect it that it will require only a very small figure of percentage to produce an effect on the ultimate strength or hardness of the metal. I would like to hear from Mr. West to know if he has made any determination on that point.

W. N. Moore: There is one thing which Mr. West cites, and that is the increasing graphite in remelting, I would say as merely corroborative evidence that we have found to our surprise that to be the case. We had supposed, until the evidence was accidentally brought up, that the more we remelted iron, the more we burned the carbon out of it.

Mr. West: Mr. Knight suggests several points which it is well to discuss. In the case of the melting of hard iron cited by Mr. Bell, more fuel is required in order to bring the metal up to a high state of fluidity. Mr. Knight gives that as evidence that soft iron will melt faster than hard iron. Foundrymen that are used to working with white iron or chilled iron know that it loses life very rapidly; and foundrymen of experience can tell by the eye whether or not the metals they have in any two ladles are about equal in their fluidity and temperature. If we have a ladle of hard iron side by side with a ladle of soft iron, which to the eye look equal in temperature, we know by experience that the white iron will very soon lose its fluidity. The soft iron will retain its life at times in a big ladle an hour longer than hard iron would. It is no reason, because hard iron solidifies quicker than soft iron, that the soft iron has a lower fusing point. The other question about silicon, was with reference to my conclusion that the longer iron remains in contact with the fuel in the cupola and gases, the more it reduced its silicon. Now, these experiments and analyses which we have in this table show plainly that when we contrast them with the time of melting, there is far less silicon reduced where we melt iron quickly than slowly; and I think all experiments in the future will bear that out. The analyses in Mr. Knight's paper of yesterday show that the first iron is higher in silicon than that which follows after and I stated yesterday that that was due to the fact that that iron melted quicker. I know when we start, after we melt the first hundred pounds or two, that our iron melts faster than it does any time after; and that is due to the fact that our cupola is clean; there are no chillings around the tuyeres; the openings for the blast are free; there is very little slag in the cupola, and all conditions are favorable to bringing the iron down fast; so when it gets down to the melting point, it don't take it as long to get to the fluid state, as it does further along in the heat.

A vote of thanks was extended to Mr. West for his able paper.

Secretary E. P. Wilson of the National Association of Manufacturers, made a brief address on the scope of the work of that organization, and asked the influence of the members to secure the next convention of the American Foundrymen's Association for Cincinnati.

The members and visitors then adjourned to the front of the Grand Hotel where a group picture was taken.

Tuesday Afternoon.

At 2 P. M. the members and others in attendance at the meeting took special trolley cars from the front of the Grand Hotel, and were shown through the suburbs, stopping according to previous invitation to inspect the plant of S. Obermayer Co., where a collation was served, the party returning about 6 P. M.

Upon the invitation of the local committee of arrangements, the visitors dined with the Cincinnati foundrymen at 8 P. M.,

at the Grand Hotel. The occasion was quite informal. About 100 sat down. When coffee and cigars were reached, speaking began, and the intervals between speeches were filled with music and other entertainment. Mr. Geo. McG. Morris acted as toast-master. Speeches in response to calls were made by C A. Sercomb, president of the Western Foundrymen's Association; George M. Sargent, of Chicago; Geo. W. Cope, Chicago; James A. Green, Cincinnati; L. Kahn, Hamilton, O.; Henry Gossiger, of Cincinnati; D. B. Meacham, of Cincinnati. John A. Penton, of Detroit, called attention to the ceremonies of the Plumbago Club.

Wednesday Morning Session.

W. N. Moore was called to the chair, in the temporary absence of the president. Secretary Sorge presented the claims of the association, suggesting the establishing of sub-headquarters at Cincinnati, so that the same papers might be discussed simultaneously in Chicago and Cincinnati. He invited Cincinnati foundrymen and others present to give their names for membership in the association.

In the absence of D. H. Truesdale, of Cribben, Sexton & Co., Chicago, the secretary read his paper on "Molding Sand," which will be found on another page. A number of castings were exhibited by Clinton A. Truesdale, of Cincinnati, nephew of the author of the paper, these being used to illustrate some of the points made in the paper.

An interesting discussion of Mr. Truesdale's paper followed, which was very generally participated in by the foundrymen and sand men present. It will be given in full in the next issue of *The Iron Trade Review*.

Expressions of thanks for the hospitality of the Cincinnati foundrymen and associated interests were made by President Sercomb and on motion of S. T. Johnston a resolution of hearty thanks was unanimously passed and ordered spread upon the records of the association.

The announcement was made by Henry Gossiger, of the death of Chris. Erhart, one of the veteran foundrymen of Cincinnati, which had occurred on the day previous. A resolution of sympathy with the family and business associates of the deceased was passed.

At 1 P. M. the association and friends went in special cars to Hamilton, O., to visit the great plant of the Niles Tool Works Co.

WESTINGHOUSE AIR BRAKE CO'S FOUNDRY.

Early in 1890 the Westinghouse Air Brake Co. was compelled by the crowded condition of its Pittsburg plant to find a new location. The present plant at Wilmerding, 14 miles east of Pittsburg, on the Pennsylvania Railroad, resulted, and the removal was completed before the close of the year. The plant as built consisted of three principal buildings: The machine shop, 504 feet long by 213 feet wide; the blacksmith and forging shop, 283 feet long by 154 feet wide, and the foundry 318 feet long by 154 feet wide. Nothing was spared in the plant's erection and equipment and at the time of their completion the various departments were far in advance of anything of their kind then in existence.

In the foundry were perhaps the most novel and radical departures from accepted methods of the time, among other innovations being the connected chain of traveling tables carrying molds continuously through all the operations involved—a method never before attempted in this country. In the seven intervening years few improvements on the methods employed have been devised and this foundry still stands in the front rank of progressive American foundries.

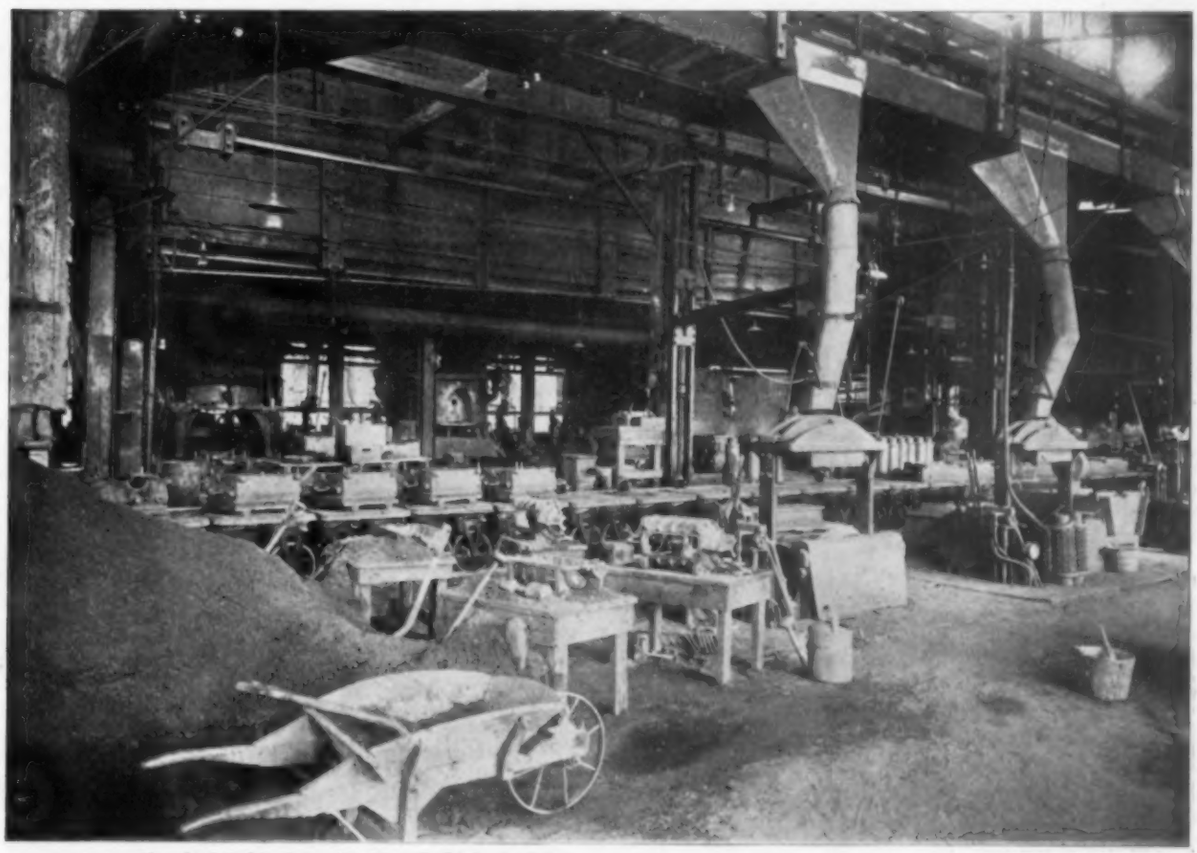

FIG. 1. MAIN FOUNDRY, SHOWING NO. 1 TABLE AND CUPOLAS.

The building as originally constructed was 318 feet long by 154 wide and consisted in reality of three rooms: The main foundry, 195x150 feet; the sand room, 60x150 feet; and a third occupied by the tumbling barrels. During the past summer an addition to the foundry was made by using a space 40 feet wide by 154 feet long between the north wall of the foundry and the blacksmith shop. This addition is now completed and a part of the main foundry. The monitor roof over the main molding room is 80 feet from the floor, and this exceptional roominess, in connection with the large skylight and side windows, as shown, make the shop one of the best lighted and best ventilated in the country.

The castings made vary in size from an air cylinder 14 inches in diameter to caps one-eighth-inch in thickness, and are of more than 200 distinct patterns. Generally, however, a considerable number of one kind are cast at once thus allowing practice not possible in a general foundry. The traveling tables are particularly adapted to casting a large number of similar castings. Three of these chains of tables are now in

use." The first, used chiefly on large castings, such as cylinders, air reservoirs, etc., is shown as it turns at its upper end in the first view given herewith. The second chain occupies the same relative position on the other side of the four cupolas, which are seen in the same view.

The construction of these two series of tables is essentially the same. Each table consists of a flat iron top, supported by two wheels beneath its outer edge and by a grooved wheel (attached by a bracket to the table top) which runs in a track extending around the circuit.

The illustration Fig. 2 gives a clear view of the third and newest of the traveling machines, which is located in the recent addition to the foundry. In this machine the tables alone move while the rollers are stationary, being bolted at the axis into a fixed steel frame.

In all these traveling series the chain of tables passes over a sprocket wheel at the upper end and is propelled by a sprocket wheel placed at the lower end. The driving sprocket wheel is mounted on a vertical shaft and power is communicated by means of a worm gear. The engine driving the tables is located on the second floor.

know Pittsburg engineers, and was installed by them. The chutes leading from the conveyors are seen in Figs. 1 and 2. The machine's construction is simple, consisting of a main bar from which is suspended by means of U bolts malleable iron flight frames. To these, steel flights are attached by means of harness leather hinges. The main bar is supported by arch bars spaced 20 feet apart, the arch bar operating on a stationary flange wheel. The power is applied at the head end by means of crank and pitman. The sand is not allowed to rise over two-thirds the height of the flight and consequently does not cause any deterioration in the leather hinge.

Hydraulic molding machines are used throughout on larger castings. These were also here first attempted in this country. The machines first used were made by Alley & Maclellan, of Glasgow, Scotland, but the American patents were bought by the Westinghouse Air Brake Co. and the newer machines were made in the Wilmerding shops.

The machines are of two sizes and work of course in pairs, a complete machine making the two halves of the mold. Their construction is simple, the frame being in the shape of an inverted U. The top is fixed and the flask is brought up against

FIG. 2.—NEW WING OF FOUNDRY AND NO. 3 TABLE RECENTLY ADDED.

The working of the table system will be readily understood. From the molders the prepared flasks are carried by the tables past the cupolas where pouring is done. By the time the table has traveled its course the casting has cooled sufficiently to be shaken out while the empty flasks return on the tables to the molders.

Flasks and castings are lifted on and off the tables by means of air and hydraulic cranes, the air hoists being used in closing on molds and the hydraulic cranes in lifting off.

Of the advantages of the table system the most conspicuous is the fact that costs have been reduced over one-half since its introduction. Another advantage from continuous pouring is that a mold may be poured and the casting cleaned and delivered within an hour of the arrival of the order, the delivery being made before the casting is cold.

Another noteworthy feature of the foundry equipment is the system of over-head sand conveyors, by means of which sand is first lifted from the sand room, then carried in an over-head channel the length of the foundry and delivered through chutes to the molding machines wherever desired. The system is the invention of Heyl & Patterson, the well

it from below by hydraulic power. Four pairs of the larger size are used and seven pairs of the smaller size. The machines are easily cleaned by compressed air.

The foundry is provided with four cupolas, two of 60-inch and two of 48-inch diameter, and all are in use when the plant is running double turn, as was the case nearly all of the past year. Each cupola is run about seven hours and thus pouring is practically continuous. The charging floor is 13 feet above the molding floor and a trestle permits of bringing cars directly to the charging door for unloading. In pouring, metal may be carried by hand in small ladles, but the larger ladles are conveyed by means of an over-head trolley to any part of the foundry. A new device recently added to the cupola is a combination of two spouts of different lengths which permit pouring into two ladles at the same time.

Cleaning of castings is accomplished by 20 tumbling barrels. An interesting feature here is worthy of note. The sand falling from the tumbled castings is sifted through a close sieve under the barrel bottom and falls into conveyors by means of which it is taken overhead to the sand conveyor. Sand mixing is done by a Sellers mixer.

The electric lighting equipment is very complete and permits of the operation of the plant at night with all the efficiency attainable in the day time. There are ordinarily employed about 225 men. Comparatively few skilled molders are required, owing to the general use of machines.

The foundry is ably superintended by Samuel D. Sleeth, who has been at the helm since the starting of the new plant seven years ago.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The October meeting of the Pittsburg Foundrymen's Association was held Monday evening, Oct. 25 in the association rooms in the Builders' Exchange. There were present 23 members.

In the election of officers which was the first business, the sense of the association was expressed by Mr. I. W. Frank who spoke of the able direction of affairs during the past year and urged that, in view of the dangers that sometimes threaten a young organization, the experienced leaders of the past year be retained. The old officers were accordingly re-elected as follows: President, Robert Taylor; vice-president, Wm. Yagle; secretary, F. H. Zimmers; treasurer, Jos. S. Seaman.

Mr. Frank brought before the association the question of inviting the American Foundrymen's Association to hold its next annual meeting in May, 1898, in Pittsburg. The matter was discussed informally and a committee consisting of Jas. R. Mills, Jr., Samuel D. Sleeth, Wm. Yagle, D. L. Evans and John A. Logan was appointed to consider the matter more carefully and report at the November meeting as to the advisability of acting on the suggestion.

The paper read by Thos. D. West before the Western Foundrymen's Association at Cincinnati on the "Comparative Fusibility of Foundry Metals," was the foundation of the evening's discussion.

The first paper prepared by Mr. West on this subject was read before the June meeting of the Pittsburg association and much interest was aroused by this second paper. It was read by Dr. R. Moldenke. The fact that Dr. Moldenke had assisted in its preparation added interest to its presentation by him. A spirited discussion followed, in which was considered, among other points, the effect likely to follow in foundry practice from the introduction of sandless pig iron cast in chill molds and cooled gradually by water. Mr. Frank made the point that the introduction of the system would remove foundry practice from the confines of guess-work and make it a matter of known causes and effects. An interesting discussion followed on the properties, causes and occurrences of kish. The causes and remedy for iron burning in the cupola were also touched upon and many facts of interest were brought out in the informal interchange of experience.

Furnaces That Will Never Go Again.

The *Bulletin* of the American Iron and Steel Association says: "Among the blast furnaces which have long been idle and which are not likely to resume operations at any time in the near future are the following: It may be safely assumed that a number of the furnaces named will never again make pig iron: The two charcoal furnaces of the Chateaugay Ore & Iron Co., of Plattsburgh, N. Y.—Plattsburgh Furnace, first blown in in 1878, and Standish Furnace, first blown in in 1887; the furnace of the Franklin Iron Co., at Franklin Furnace, N. J., built in 1873; Northampton Furnace, of the Northampton Iron Co., at Freemansburg, Northampton Co,, Pa., blown in 1873; Duncannon Furnace, of the Duncannon Iron Co., at Duncannon, Pa., built in 1853; Principio Furnace, of the Whitaker Iron Co., at Principio Furnace, P. O., Cecil Co., Md., built in 1889-90; La Grange Furnace, at Stribling, Stewart Co., Tenn., built in 1832; King Furnace, of the Rockdale Mining & Mfg. Co., at Rockdale, Maury Co., Tenn., built in 1890; Coosa Furnace, of the Gadsden Iron Co., at Gadsden, Ala., built in 1882; Decatur Charcoal Iron Furnace, of the Decatur Land Co., at New Decatur, Ala., built in 1887-88; Tecumseh Furnace, of the Tecumseh Iron Co., at Tecumseh, Ala., built in 1873; Langdon Furnace, at Langdon, Cherokee Co., Ala., built in 1873; Pine Grove Furnace, of Means, Kyle & Co., at Hanging Rock, O., built in 1827; Baird Furnace, of the Baird Iron Co., in Perry Co., O., built in 1874-75; Carp Furnace, of the Carp River Furnace Co., at Marquette, Mich., built in 1872-73; Eureka Furnace, of the Eureka Iron & Steel Works, at Wyandotte, Mich., built in 1855."

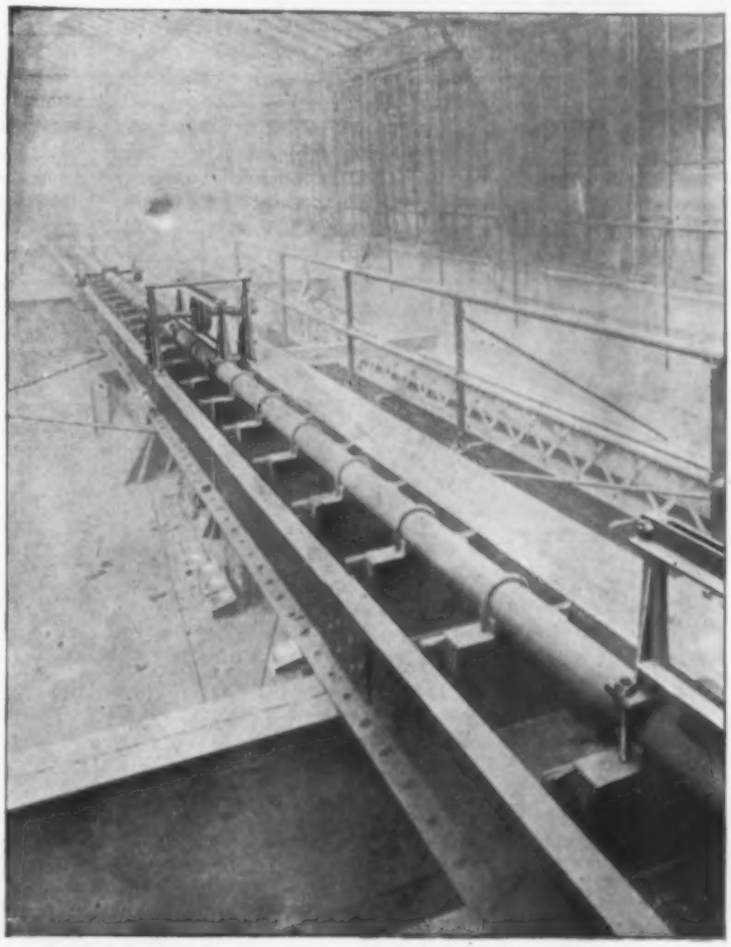

FIG. 3.—HEYL & PATTERSON SAND CONVEYOR.

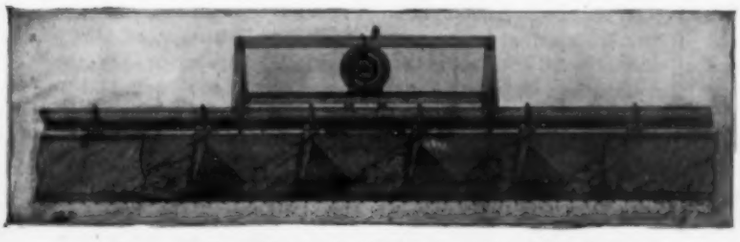

FIG. 4.—LONGITUDINAL SECTIONAL VIEW OF CONVEYOR.

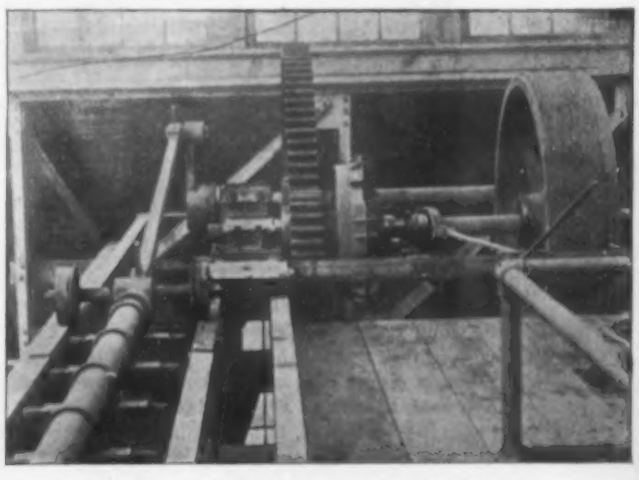

FIG. 5.—SAND CONVEYOR DRIVING GEAR.

UNIT SYSTEM OF GEARING AT THE TENNESSEE EXPOSITION.

BY S. GROVES, M. E.

The most striking object at the World's Fair (1893), was the Ferris wheel. The most conspicuous object at the Tennessee Exposition of to-day is the Giant See-Saw. The former was designed by the late G. W. G. Ferris, C. E. of Pittsburg, a Northerner; the latter, by A. J. Dyer, C. E., of Nashville, Tenn., a Southerner. Failure was predicted of both these unique mechanical inventions. Both have proved to be triumphs of engineering skill. Everybody either saw or read of the wonderful wheel on the gay Midway Plaisance, at Chicago, which whirled the sight-seer up into the air to the dizzy height of 250 feet, whence could be seen the glorious panorama of the White City, and the blue waters of Lake Michigan beyond. All, however, have not seen the Giant See-Saw in operation on Vanity Fair, at Nashville, which sways the strong nerved visitor up into the bracing air of Tennessee, to an altitude of 180 feet, where a fine view is obtained of the stately buildings, picturesque grounds, and glistening lagoons of the Southern fair, as well as points of interest in the environing country; such as the old forts and battle field of Nashville, the famous Belle Meade stock farm, and the Hermitage of President Jackson.

It will be seen by the excellent illustration in Fig. 1, that the support for the cross-beam, or see-saw, consists of a central tower of structural steel, formed of four legs, covering an area at the base of 30 feet square, and meeting at the top.

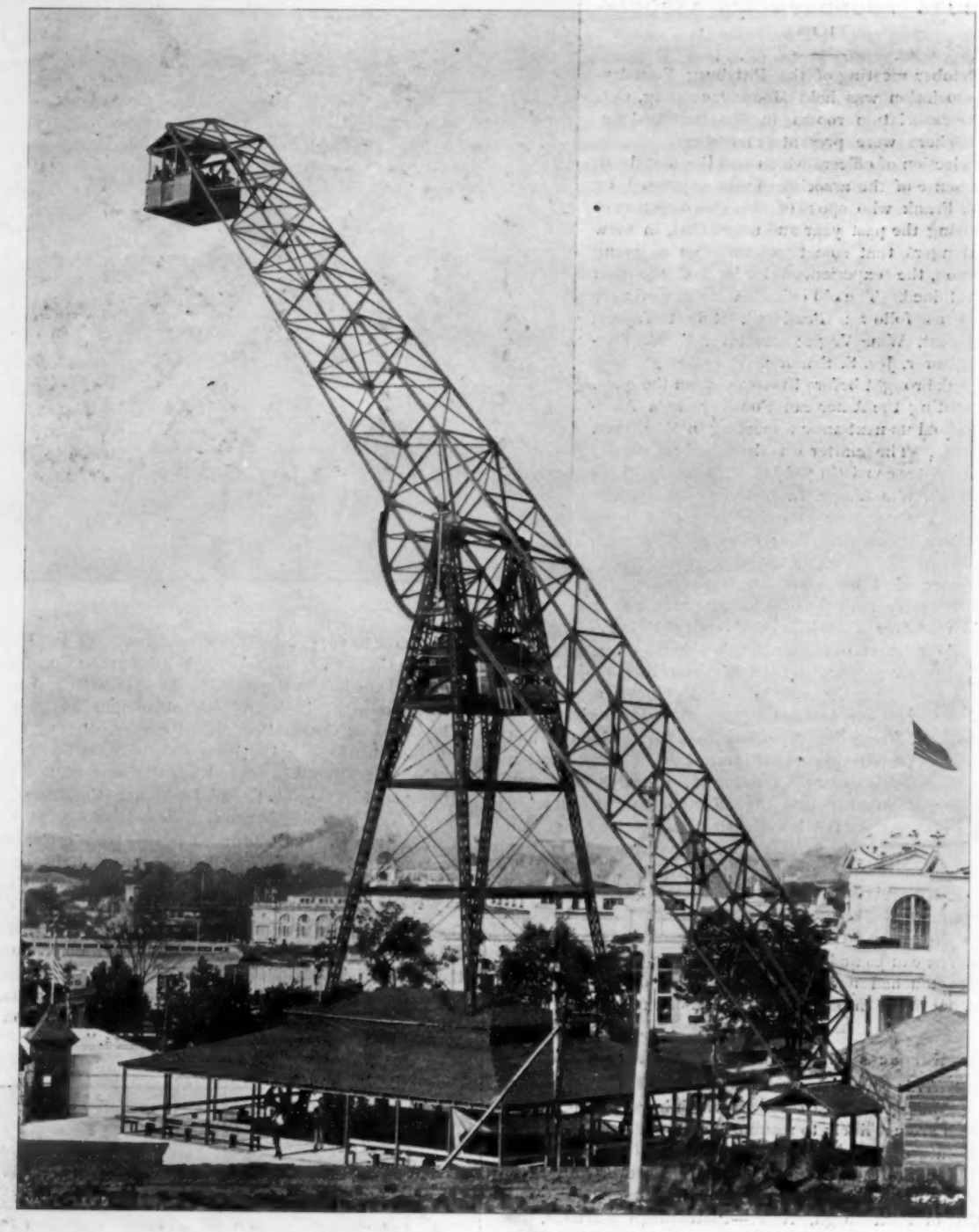

FIG. 1.—GIANT SEE-SAW AT NASHVILLE EXPOSITION.

The perpendicular height from ground to center of pin is 75 feet. The cross-beam is 11 feet 3 inches square at middle, 6 feet at ends, and 160 feet long over all. At each end of the see-saw is a car 7 feet 6 inches by 9 feet 1 inch, designed to carry from 12 to 15 persons. When one of these cars is on the ground, the other is up in the air 180 feet. The strain on the arc due to a live load in the car is about 7,000 lbs., while the weight of the arc when up, is some 25,000 lbs., being necessarily much greater than this when the machine starts or stops in a horizontal position. The motive power for operating the device, (15 h. p. engine and electric motor—650 revo-

lutions), is located immediately underneath the center of the cross beam at the top of the tower. The swinging of the cross beam on its axis, is performed by means of two parallel, segmental radial racks (as shown), each 25 feet long. The teeth engage into a pair of 21-tooth pinions, driven through a set of intermediate gears from the motor. These rack pinions make 2.67 revolutions per minute, thus lifting each car from the ground to its utmost height, in about 1¼ minutes. Such, is a brief description of the gigantic mechanical toy, which has given pleasure to thousands, at the popular exposition in the South.

I now proceed to deal with the subject, which evoked this paper, namely, the special form of gearing employed in the operating mechanism of the see-saw, conceiving that a detailed description of the novel features contained therein, would be of interest to the readers of *The Iron Trade Review*.

If ever there was a case in which it was necessary to have every part of a machine mechanically perfect, and of adequate strength, it was in the designing of this see-saw; for, the slightest derangement, or mishap, when swinging a carload of people up into the air, would be fatal to the financial success of the enterprise. When, therefore, the question of racks and final pinions for same came under consideration, the consulting engineer, Gustave Kaufmann, C. E., of Pittsburg, placed the making of this special work in my hands, as representing Taylor, Wilson & Co., of Allegheny, Pa. Without hesitation, I decided to adopt the unit system of gearing for the racks and pinions, having proved by hard earned experience that for safety and smooth running, gear teeth designed on this plan are immeasurably superior to the method of having two or three long teeth in contact at one time.

In 1894 the writer published an illustrated article in the

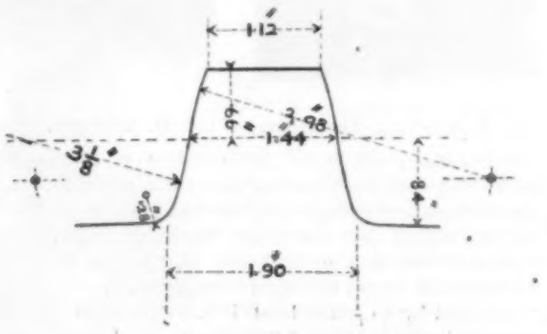

FIG. 1.—CONTOUR OF RACK TEETH.

leading technical journals, entitled "A Revolution in the Gear Trade," setting forth reasons for the adoption of short teeth for high powers. This was the first public advocacy of the unit system in this country, and evoked considerable discussion. Wm. Kent, C. E., editor of the Engineer's Handbook, applied for my formula, for insertion in his new book. Since that time, all the leading manufacturers of machine molded gears, with one exception, have fallen into the procession. At the last meeting of the American Society of Mechanical Engineers, Mr. C. W. Hunt, strongly supported the one-short-tooth-in-gear system. He said: "We eventually tried the experiment of shorter teeth, and the results were exceptionally fine. They ran more like cut gears than like cast ones, and were obviously much stronger." In view, therefore, of this revival in high places of the controversy which I started in this country some four years ago, the notable example of the use of short teeth in the operating mechanism of the famous see-saw down South, seemed to me an opportune moment for restating the reasons for using unit gearing, which seemed to have been overlooked by some recent advocates.

The pair of rack teeth were to be 12 feet 6 inches on pitch line, each made in six segments, making a total length of 25 feet, 9 9-32 inches by 15 inches wide, with teeth 3-inch pitch, 8 inch face. Ordinarily, epicycloidal teeth of this pitch, would have been made 2.1 inches long from root to point, whereas they were actually made 1.5-inch long. See Fig. 2. As short teeth, these were made considerably longer than our usual practice, due to a consideration of the fact that the structure to which the rack segments were to be bolted would not be absolutely rigid, but be liable to spring and hence result in a changing, rolling circle. The segments were not machine molded, but made from full patterns. The strong objection to pattern molded gears, however, namely, draft in the face of the teeth, was entirely overcome by molding the teeth horizontally; particular care being taken to reduce rapping to a minimum.

The pair of pinions were 20.13-inches pitch diameter, 21 teeth, 3-inch pitch, 8-inch face, 7-inch bore and were machine molded, with single tooth block, the withdrawal from the mold being performed by means of my patented drawback device. The teeth were molded in special sands, coated with a refractory solution and subsequently skin dried. Each casting weighed about 600 lbs., and as regards accuracy of pitch, definition of form and smoothness of skin, were all that could be desired.

In the specification of the work, it was stipulated that the racks and pinions were to be made of steel. Upon pointing out, however, the difficulty of procuring steel castings entirely free from blow-holes and corrugations, added to irregularity of form, and abnormal strain on the corners of teeth, due to rapping, and draft of the full pattern, from which steel gears would be made; at the same time guaranteeing to make them of semi-wrought iron, having a tensile strength of at least 30,000 lbs. per square inch, and with teeth almost as sharply defined and smooth as cut gears, the alteration was permitted; and the whole of the castings were made from a mixture of the best charcoal pig irons, and wrought iron of first class quality.

An economical method of preparing this semi-wrought iron or semi-steel is to charge the pigs and bars into the cupola at the end of a day's heat, when the lining is almost incandescent, pouring the resultant metal mixture into pig molds, for use in subsequent remeltings. In this way perfect amalgamation may be attained, care being taken to provide by analy-

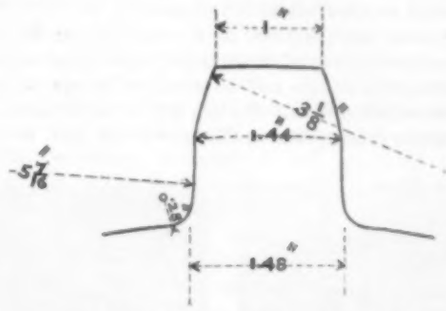

FIG. 2.—CONTOUR OF PINION TEETH.

sis that the silicon in the first charcoal pigs is in sufficient quantity to ensure in the final casting a percentage of combined carbon, differentiated to suit the varying sectional needs of the metal in the respective sized gears. Otherwise, there will be trouble in the machine shop.

Having set forth in detail the proportions of the rack and pinion teeth, and having described the mode of manufacture, and the material of which they were made, permit me in conclusion to state the reason why the short teeth used thereon have proved such a signal success. First, a negative view. Had the conventional epicycloidal form been introduced, the dangers of the breaking of the teeth would have been greatly increased. In any form of gearing only one tooth can roll in contact with the tooth in the opposite gear; the second tooth in contact must necessarily slide on the point. This fact is demonstrated by the universal phenomena of the scooping out of the teeth below the pitch line, and the sharpening of the teeth above, to a knife edge, leaving a ridge on the imaginary pitch line which is thus clearly defined. And since the angle of teeth when two pairs are in contact at a time, is comparatively large, the danger of driving the points of the rack teeth—owing to the flexible structure of the cross beam to which they were connected—into the roots of those in the pinions and breaking them off at the roots, would have been very great. On the other hand, with short teeth, and only one pair in contact at a time, and then only at small angles, the danger of driving the points of the rack teeth into the roots of those of the pinions, was reduced to a minimum; and especially so, since with short teeth, the cantilever strain of long teeth is transformed into a shear strain. The teeth have to be shoved off, not snapped off, at the roots.

In thus describing the Giant See-Saw, and its operating mechanism, I am hopeful of having made out a good case for the general use of short teeth for high powers—which I have defined as the unit system of gearing.

WESTERN FOUNDRYMEN'S OFFICERS.

The officers of the Western Foundrymen's Association are as representative a group of Western foundrymen as could well be gathered together. With one exception they are all experienced foundrymen, having been in the business for years—most of them all of their business lives. The interests of the association could not be in better hands.

C. A. Sercomb, the president, is one of the best known men in Milwaukee, not only as a foundryman, but as a business man. He is always found in every movement that promises

C. A. Sercomb, President.

to benefit the city. He is a foundryman of long experience, having been connected with the firm of Schwab & Sercomb, stove and furnace manufacturers, for many years. His father was a member of the firm of Turton & Sercomb, pioneer founders and machinists of Wisconsin. Mr. Sercomb has held the office of vice-president of the association, and was one of the first members, his election to the presidency being looked upon as a well-deserved promotion.

The present vice-president of the association, Wm. Ferguson, is superintendent of the foundry department of the Gates Iron Works, of Chicago, and is considered one of the best foundrymen in the West. He has had 28 years' active experience, being a journeyman in Glasgow at 16, and working up

Wm. Ferguson, Vice President. A. Sorge, Jr., Secretary.

to his present position through all the "jobs" that a molder and foundryman foreman can hold. Mr. Ferguson is progressive, and devotes much of his time to experiments to better his practice.

The secretary of the association, A. Sorge, Jr., M. E., has held the office during two terms. He is a graduate of Stevens Institute, with the degree of M. E., and has held several important positions with large iron-working concerns. He is at present a consulting engineer, devoting special attention to the improvement of foundry practice, and in connection with his business in that line he represents two Eastern manufacturers, the Harrison Safety Boiler Works, of Philadelphia, and the A. A. Griffin Iron Co., of Jersey City.

O. T. Stantial, treasurer, is works superintendent of the Illinois Malleable Iron Co., of Chicago, and has an enviable reputation as a foundry manager. The standard of his foundry is kept high and he is progressive and alert for improvement. Mr. Stantial has been connected with several of the largest concerns in Chicago.

Of the board of directors, G. H. Carver is the superintendent of the Plano Mfg. Co., of West Pullman, and one factor in the success of this concern in the manufacture of agricultural implements is the excellence of the castings made under his direction. Mr. Carver always has something pertinent to offer when questions of actual foundry practice are up for discussion, before the association.

A. W. McArthur, president of the Rockford Foundry Co., of Rockford, Ill., is another of the old members of the association. Last year he held the office of president, and filled it with credit. His company, while not the largest in his town, is a leading one, and is well managed and profitable.

J. M. Sweeney is also an ex-president of the association. He is a resident of Chicago, and is interested in the Chicago Consolidated Iron & Steel Co., which owns a plant at Harvey, Ill. Mr. Sweeney came from Wheeling, W. Va., where his father for many years operated a large plant for the manufacture of heavy tools and engineering work, under the name of A. J. Sweeney & Sons. Here J. M. Sweeney had a varied experience and has since been engaged in positions bringing into play his training as manager and engineer.

O. T. Stantial, Treasurer. Jno. M. Sweeney, Director.

W. N. Moore has been vice-president of the association, and in that capacity has often presided at the meetings, showing skill and tact in begetting and directing discussion. He is the president of the Joliet Stove Works, of Joliet, Ill., one of the largest concerns of that city and maker of a product which is well known throughout the country.

Last, but by no means least, is S. T. Johnston, the "exception" spoken of in the first paragraph. Mr. Johnston probably knows as many foundrymen as any other man in the country. As secretary of the association for a year he was instrumental in adding many names to its roll. Energy and genuineness are characteristic traits and it is not surprising that they have brought friends as well as business success. He represents the Whiting Foundry Equipment Co.

G. H. Carver, Director. S. T. Johnston, Director.

The first train run on the Pittsburg, Bessemer & Lake Erie Railway left Conneaut late Sunday night and arrived at North Bessemer Monday afternoon. The bridge work leading to Bessemer was completed Tuesday and the train crossed to the Edgar Thomson Steel Works. It consisted of 52 steel cars, carrying 1,515 gross tons of ore.

THE MICROSCOPE IN THE STUDY OF IRON.

BY DR. R. MOLDENKE.

When Dr. Sorby published his first paper on the use of the microscope in the study of steel, the iron world could hardly have been aware of the far-reaching consequences this new method of research would bring about in the attainment of scientific knowledge. We know how difficult it is for an investigator to accept the statement of a fact on faith, to say nothing of a theory. Yet it is interesting to look back two decades ago, to follow up the developments of the then current theories of the medical profession, comparing them with the achievements of bacteriological research at the present day. Look where you will, the means given to man to pry deeply into the minute workings of Nature amply repay him, mentally, if a student, materially, if a director of affairs.

It is but natural that the results obtained by many workers, as a consequence of Dr. Sorby's initial step, should be conflicting and to some extent misleading; but those who were endowed with the necessary tact to withdraw their views gracefully when the preponderance of evidence was against them, naturally assisted in shaping the directions into which this new method of investigation was destined to branch out. Thus it was that the names Martens, Osmond, Behrens, Ledebur, Howe, Arnold and others became associated with that of Dr. Sorby as pioneers of the apparently true method of studying iron by means of the microscope.

It is rather odd that the micrographic study of metals and alloys should have taken them practically out of the more artificial field of definite chemical compounds, and placed them with the minerals, where nature has mixed up the elements in the most wonderful fashion, and yet on regular and well-defined lines. Prof. Howe in his "Metallurgy of Steel" brings this out in his usual trenchant style. It would look as if metallurgy is merely man's method of undoing what nature did in its own way of producing minerals. Chemistry gives us only the means of planning and carrying out these methods; and the microscope is destined more than any other instrument or method to show us what we have obtained.

RICHARD G. G. MOLDENKE was born at Watertown, Wis., in 1864. His early education was received in New York City, and he graduated in 1885 from the Columbia University School of Mines as a mining engineer. His researches in chemistry brought him the degree of doctor of philosophy two years later. He had a varied experience in the next few years, being engaged on hydrographic surveys for the U. S. Coast and Godetic Survey and later worked in the newly opened field of electrical engineering. In 1889 he was called to the chair of mechanical and electrical engineering of the Michigan College of Mines. This position he resigned a year later, to return to active work. His taste for engineering when combined with metallurgy led to his accepting the position of consulting engineer to the McConway & Torley Co., of Pittsburg, and for seven years he has been connected with that well known company. Dr. Moldenke's acquaintance with iron and steel metallurgy and processes is intimate and of wide range. He is considered one of the foremost experts in the country on malleable castings, which are a specialty of his company. He is a thorough believer in the application of science to every branch of operations in iron, and has contributed not a little to the advance toward greater certainty in results in the foundry. With broad training and an indefatigable spirit of investigation, Dr. Moldenke has made rapid progress, not along beaten tracks but along paths that have not been generally traveled. His article in this issue is rather a prophecy of methods that will be more common when investigators like himself have given a few years more of study to the unsolved problems of cast iron. We are glad to refer in this connection to the identity of Dr. Moldenke and the "M." which has become a familiar signature to the excellent digests from the technical press that have appeared in these columns for some weeks. These condensations, which have involved in many cases translations from German and other journals, have meant a vast deal of painstaking labor, and we are glad to know that they have been appreciated by our readers, as well as by the many of our contemporaries who have felt free to appropriate them.

In this country, where the general Government does not aid the scientist individually in prosecuting his researches, it has fallen to the lot of men who earn their daily bread in the laboratories of the great iron works, to develop this new branch of study on lines which will prove of the most practical value to the industry. Thus we have among others less prominently known, Sauveur, an expert on the microstructure of steel as formed during the processes it undergoes in its manufacture. While there is usually little time allowed to study steel in this manner at the various works, it would seem an achievement to be able to decide not only that the structure of a material in question is good or bad, but that its method of manufacture can be traced and criticised; or conversely, that for a desired product, the processes of manufacture can be indicated beforehand.

At the fifth international conference for establishing a uniform system of testing materials of construction, resolutions were passed favoring the extended use of microscopic methods of investigation—"because it has been found that the rapid progress made in the last few years will undoubtedly be supplemented. It is therefore recommended that steps be taken in all countries to aid in establishing facilities for the extended study of metallography as an aid to chemistry and physical tests, for it will supplement our knowledge of the nature of metals in many ways."

Carbon the Chief Factor in This Study.

We find the application of metallographic research in line with the unscientific way the foundry has been run when compared with steel, which is based on exact knowledge altogether. We read many interesting things about steel, but we do not see pig, or cast iron mentioned. True, a few attempts have been made to look into this end of the subject, but in isolated cases only, and then with a single kind of iron. It is the writer's endeavor therefore to call attention to this neglected branch of the study and to outline a few directions which could be followed out profitably.

First of all, what varieties, or rather alloys, of the element iron are used in the foundry? This brings us to the root of the question at once. Iron, chemically pure, a rarity, cuts no figure in the trade. With a little carbon it gives us the gradations of wrought iron, and steel from soft to hard. More carbon and you have pig irons, and from these, among other products, cast iron. The other metalloids to be found in iron necessarily effect the metal materially; but so far as our study is concerned, carbon really forms the chief element to be considered. Take therefore a pig of iron and look at its carbon. We find most of it in the shape of graphite, the balance combined carbon. This is for gray iron; in the case of white irons it is reversed. This state of affairs brings us at once to a variation in the line of study as applied to steels, where there is little or no graphite; and this may necessitate modifications in the method of preparing the samples.

It is not the purpose of this article to go into the action of the various metalloids in influencing the condition of the carbon in pig iron and castings in general, but on looking over a table of analyses of such materials we note that there is always some combined carbon present. This, then, would indicate that, apart from the mechanically mixed graphite, the balance of the metal would be in reality a steel containing very likely an excessive amount of impurities. This then brings us to the consideration of the combined carbon in more detail, and here we run into the mineralogical aspect of the question.

Chemical investigation has shown us that there are two distinct forms of combined carbon. In current practice they have become known as hardening carbon, being a characteristic constituent of steel heated beyond the point of recalescence and quenched; and carbide carbon, formerly called cement carbon, on account of its prevalence in the old cement steel. This form of carbon is characteristic of annealed steel. These varieties of combined carbon, of course, exist only in chemical combination with iron in the material, and the nature of these combinations has given rise to some of the

mineralogical terms under which the various discernable constituents of steel go at the present day.

Right here we strike what seems to be a misnomer, pure iron in steel being called ferrite. What special reason the originator of this term had to call iron thus, is a mystery to the writer; for to the practicing metallurgist the name ferrite leaves the impression of an association of iron with oxygen. For instance, cuprite, is an oxide of copper; zincite, an oxide of zinc; manganite, the hydrated oxide of manganese, etc. Iron has been found in the natural state, though

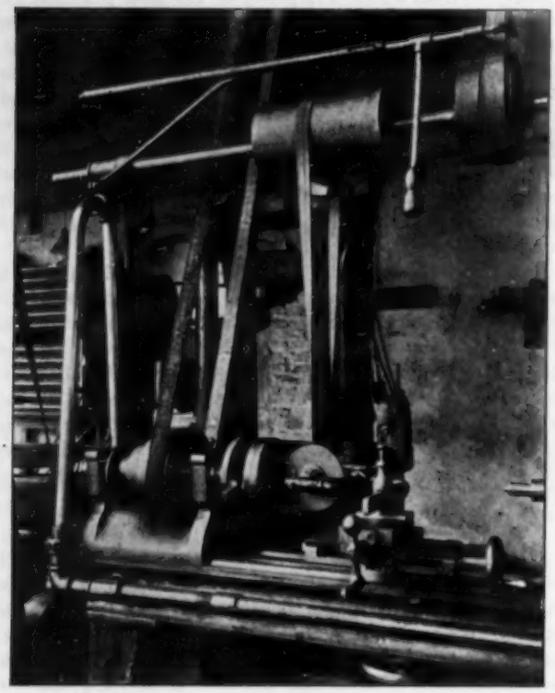

FIG. 1.

very rarely, and is not known to the mineralogist as ferrite, any more than native antimony, arsenic, gold, or silver, have had their name changed to make a distinction without a difference. Here is food for thought. And it is respectfully suggested to the master minds laboring to advance science that the true method is to simplify, not amplify, scientific terms.

Coming next we have the combination of the iron with the carbide carbon. This is a distinct chemical compound which goes under the name of cementite. It is only found in high carbon steels while in the annealed state. Usually it is found dissolved in the iron of steels in varying proportions, and is then called pearlite on account of the pearly interference colors it displays when the steel is etched.

The compound of iron with the hardening carbon is called martensite. It has no definite chemical composition, and exists only in highly heated steel. This constituency of steel can be kept unchanged by rapid quenching. We have then to deal with iron, cementite, pearlite, and martensite in studying steel and iron. Add to this the graphite, and we have the field broadened to include pig iron, cast iron, rolls, car wheels, etc.

Other Elements to Be Considered.

But another phase of the question presents itself to our consideration. Granted that you can master the carbons, and the consequent range and variety of results they bring out while studying the hardening and annealing processes, with their modifications of tempering, case hardening, and combined treatment. In foundry work we have to deal with special extremities brought about by the comparatively high amounts of phosphorus, sulphur, mangarese, and traces of arsenic, copper, etc.; not to speak of the silicon, which may be made a power for good, when contrasted with the elements just mentioned.

In what shape does phosphorus exist in iron? As a simple phosphide of iron, possibly, and yet it may be of more elaborate constitution. But as to structure, is it like the sulphide, easily fusible, having the disagreeable habit of flocking by itself, and thus forming a weak mortar between the crystals of strong iron? It is bad enough if this sulphide of iron occurs in the metal as microscopic shot, but when it runs as a net work of veins throughout the mass of iron, and especially across the line of strain instead of along it, we have cause for the greatest apprehension in using this material for important work. So also the other elements to be dealt with; and when we look at the fact that graphite itself is the cause of innumerable planes of weakness, we must wonder whence the iron gets its strength, when the supposedly reliable structure remaining around the graphite is weakened by foreign influences. Here, then, are problems in molecular physics which require solution, and which form a field ten times as large as that offered by steel, which in its turn has already disclosed so much valuable information.

This much has been said of the iron before it leaves the foundry. What could not be added regarding the service requirements of the finished castings, the deterioration or fatigue of metals, and the accidents which cause a failure of the material. Here is a fruitful field which is ably exploited by Andrews in England, so far as steel is concerned. He rightly says that in his opinion "the deterioration or fatigue of metals is probably due to the gradual loosening of the cohesion along the intercrystalline spaces or lines of junction of the ultimate crystals constituting the metal, the gradual loss of cohesion being induced and promoted by the repetitions of stress or vibratory strains, the effect being intensified, and perhaps in many cases primarily induced, by the presence of internal microscopic flaws or germs of metallic disease."

How to Prepare Materials For Investigation.

We come now to the practical side of the subject. The methods employed to prepare materials for study, and how to record the results obtained for future reference.

The irons to be investigated in the foundry are usually of the soft variety, so that the plain hack saw can take care of them in preparing samples. If hard irons are met with, the writer has yet to see a piece which could not be cut in the shaper by the aid of special brands of steel made for just this purpose. In any event exceptionally hard pieces could always be handled by the emery grinder. Stead, of England, and Sauveur, in this country, give descriptions of excellent devices to prepare and mount specimens, but the conditions to be met within the foundry are usually such that a little

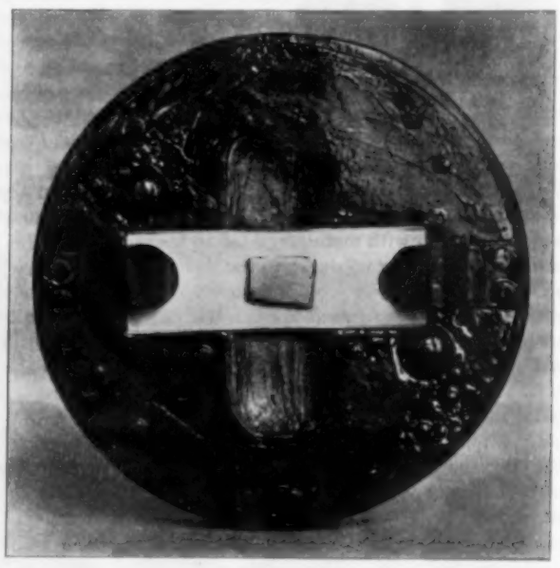

FIG. 2.

more uniformity is desirable, even if it takes more labor to prepare the sections in the first place, most of which can, however, be relegated to cheaper helpers. Thus it is that the writer cannot recommend picking up an odd piece, grinding and polishing a spot on it, studying this and then throwing the sample away.

It is well known that we learn more from bad or ruined material than from the manifestly good, so that when it becomes necessary to trace out the causes of imperfect work, it pays to keep the results near at hand. It is therefore well to

prepare and mount the sections for continual reference, and this is best done by employing the regulation glass slide used for general microscopic purposes. The face of a section of iron need seldom exceed three-quarters of an inch along the largest side, and when mounted parallel to the slide, it may be up to one quarter inch thick without causing any inconvenience. After grinding, polishing, and etching, the section may receive a cover-glass, but as a rule it is best left as it is, so that it can be studied to better advantage, and also form a better subject for the camera.

As every foundry is provided with power, it becomes an easy matter to arrange a small hand lathe in such a manner

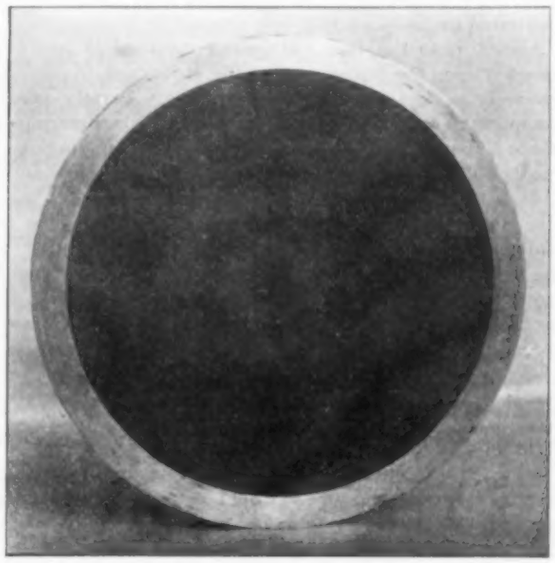

FIG. 3.

that a section may be trued up sufficienly to serve as a basis for the finer polishing. In general, the section after cutting is fastened to the glass slide in the usual way, care being taken to press it on firmly. It is next placed in the lathe and ground flat, as shown in Fig. 1, the lathe running at its highest speed.

Care must be taken to feed the emery wheel very cautiously and only at intervals, so that the section is not heated, otherwise it will fly off and cause unnecessary trouble and delay. Further treatment will now depend upon the condition of the section. If it is fairly smooth and free from deep scratches it can be polished at once, if not, finer grinding must precede this operation.

Fig. 1 is self explanatory to any one having to do with machinery. It is only a simple device to have the section revolve quickly, while the emery wheel, also running at a high speed, is passed along its face at the same time, thus taking off the slightest amount of metal, but bringing out a plane surface parallel to the glass slide. Fig. 2 shows the construction of the slide holder more clearly. A steel disk fitted with a plug having the proper taper serves as the foundation of this device, as also of another described later on; and is practically a face plate for the lathe. On this disk is bolted another disk of wood. This piece of wood is faced by a third disk, of sheet iron, the thickness of the slide, and cut out as shown. The wooden disk is also grooved out in such a manner that the fingers can be used for quickly inserting or taking out the glass slide. Spring clips hold the slide firmly in place.

For the grinding, as well as some of the polishing, the writer formerly made use of disks of hard wood attached to the above mentioned face plate, on which were glued the various kinds of emery cloth. Considerable trouble was experienced from the tendency of the wood to warp, thus causing the disks to run out of true and consequently render them unfit for the work in hand. It was with pleasure, therefore, that a modification of Prof. Arnold's apparatus was adopted, as shown in Fig. 3. Instead of a wooden disk, an iron one is used, on which the emery cloth is stretched by means of a steel ring. This device gives excellent satisfaction and is used with the lathe running very slow, the mounted section being pressed gently against the cloth and frequently held at different angles in the grinding plane. In this manner good results are obtained, and by using newer cloths to begin operations, and the old and worn ones to end them, the section is left smooth and free from all but the slightest scratches. Hand polishing is now resorted to as the best method of completing the work. A planed block of cast iron is taken, and on it is mounted a piece of cloth well pressed down. The finest and best washed grade of rouge obtainable is now sprinkled on this cloth and the section carefully polished to remove practically all but the last traces of microscopic scratches. This method is employed when a dead flat result is desired. When, however, a species of relief polish is to be produced, that is, when the softer parts of the section are to be cut away by the entrance of the flexible bed leaving the harder portions to stand out in relief, the cloth is mounted on soft wood, or better still, on a sheet of rubber steam packing. This method is advised by Mr. P. Kreuzpointner, the well known expert on the physical properties of iron and steel.

While polishing, etching can also be done. Prof. Osmond recommends for this purpose an infusion of licorice. This process enables one to study the section while it is being finished up, an important item in this line of investigation. Polishing sections which are not to be etched is very tedious work, as it must be confessed that it is almost impossible to attain perfection. When, however, etching is to be done afterwards, and this is nearly always the case, it is not so difficult, for the structure comes out wonderfully under the influence of corrosive liquids.

In general it may be said that the lighter and more prolonged the etching, the better the result; and while one part in 500 of nitric will bring out the structure beautifully, the slower and lighter action of iodine is to be preferred. The following formulae may serve as a basis for this method of etching: Seven grammes of iodine dissolved in 200 grammes of alcohol give a mild etching fluid, while a stronger solution is made by dissolving one part of iodine and two parts of potassium iodide in 10 parts of water. The process of etching may be carried out by immersing the section in the etching fluid, face up, and keeping the fingers off, a warning which will be heeded after it has become necessary to repolish a few sections. After the etching fluid has begun to take effect, the slide is taken out and quickly washed in running hot water and then carefully dried with a clean old linen rag, precaution being taken that the slide does not become warm enough during the washing to soften the Canada balsam and thus loosen the section. The slide is now examined under

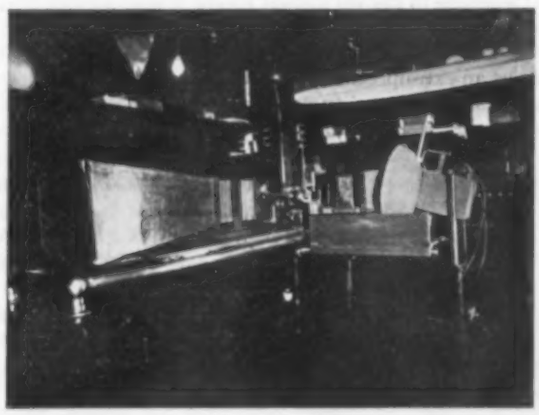

FIG. 4.

the microscope, and this process repeated until the structure is brought out in the desired detail.

Methods of Securing Records.

We come now to the question of recording the structural appearance of the metals under examination. Two methods are in vogue, each ably contended for, a combination of both probably being best calculated to serve all purposes. The first, Prof. Arnold's method, is to call to aid the camera lucida and to draw the picture as projected on the paper. It is much used in England, and does very well if the personal equation

of the artist is not considered. The second method, more flexible and therefore more in use, is to photograph the field of view by means of a camera specially arranged for the purpose. Now it will be readily seen that a careful observer who will photograph his subjects for record, and in addition will draw any special characteristic feature observeed in the section as supplementary information, will have notes of greater value than the one who uses only one of the two methods. Observations thus recorded become of great value in the process of summarizing, and for purposes of instruction a clear, sharp sketch, without blending or detail, sometimes brings out a point very clearly, which would otherwise be lost to any one not familiar with the proper valuation of photographs.

The camera lucida being familiar to every microscopist, there remains only to describe the apparatus for photographing the picture shown by the microscope. This is illustrated in Fig. 4. It will be seen that we have here a camera, microscope, and lamp; every one of these pieces of apparatus specially arranged for the purpose. While no illumniation equals that of daylight, the requirements of the work are such that means must be had to render available for immediate use a uniform and never failing source of light. This is best supplied by the arc lamp, to be met with, as a rule, in foundries generally. The photo-engraving lamp shown is tilted at an angle so that the strongest light rays may be utilized. A thin sheet of mica placed between the condensers and the lamp may prevent an accident to the glasses. These are three in number and of a curvature so calculated that the concentrated beam of light is thrown directly into the tube of the microscope. After the triple condenser system comes a solution of alum which absorbs most of the heat rays; then come two diaphragms which cut out all scattering rays, and finally a thin layer of a solution giving monochromatic light which filters out all rays but those best suited for photographic purposes, thus giving a correct color value to the negative taken. The accepted standard for this solution is 160 grammes of dry copper nitrate, 14 of chromic acid, and 250 c. c. of water. The solution is to be used .4 inch thick. The microscope is fitted with Beck's vertical illuminator, which gives a direct and very satisfactory illumination of an object even with very high powers. The camera is so arranged that a great range of movement can be had, and the whole outfit is carefully adjusted so that the lines of vision and light are exactly centered through their respective paths.

There remains in conclusion but to express the hope that the systematic study of cast iron may be taken up generally, and that the definite results so far obtained by chemical and physical methods of testing may be supplemented by the microscopic. The writer cannot help the thought, however, that somtime in the yet distant future it may happen that the case will be reversed; and that a close inspection of the iron by microscopic methods may be checked by chemical tests only as an extra precaution, in buying material for specified purposes in structural engineering.

S. S. KNIGHT, who was probably the youngest man in attendance at the Cincinnati meeting of the Western Foundrymen's Association, takes a place alongside many who count one or two decades more, when metallurgical experience is made the measure. Born in the Centennial year, Mr. Knight has just come to his majority; yet for several years he has been in close touch with the most practical side of the chemistry of iron and steel. His training has been largely under private instruction and in the work-a-day school of actual industrial operations. For the past two years he has been connected with the Addyston Pipe & Steel Co. as chemist. His first contribution to foundry association literature was a paper before the American Foundrymen's Association at Detroit last May, on "The Value of Chemistry in the Foundry." A companion piece is his paper at Cincinnati last week on "The Value of Physical Tests." Mr. Knight's part in the discussions at Cincinnati was ably carried through, showing him to be ready, resourceful and thoroughly equipped in the specialty which he has followed up with such assiduity.

THE VALUE OF PHYSICAL TESTS.*

BY S. S. KNIGHT.

The advent of various systems for the grading and mixing of irons by physical tests has led me to think that this topic, although old, may yet afford opportunity for investigation. Especially within the last year has much antagonism been shown between the exponents of these systems of physical testing and consequent foundry regulation and those who are using the means of chemical science to the same end. It is a strange, but nevertheless noteworthy, fact that the promulgators of mechanical testing have but one critcism to make on the work of their antagonists, and that is that their employment is not economical. As to how far their claims are substantiated by facts, we will now proceed to investigate.

According to the best authorities mechanical analysis is founded upon the discovery that the shrinkage in iron varies inversely as the silicon contained therein. Tersely speaking the measure of shrinkage is equivalent to the determination of the silicon. To experimentally determine if such be the case, two bars were cast one foot long and one half inch square, the same being the measurements preferably used by mechanical analysts. Both bars were cast from the same ladle of iron, one with the metal very hot and the other after the metal had been re-heated by the addition of less than five-tenths of one per cent of ferro-manganese. Time was given for the surface of the metal to strongly glow and then the second bar was poured. The bars analyzed as follows:

FIRST BAR.		SECOND BAR.	
Silicon	2.256 per cent.	Silicon	2.197 per cent.
Phosphorus	.650 " "	Phosphorus	.648 " "
Manganese	.712 " "	Manganese	1.112 " "
Shrinkage per linear foot	.11 in.	Shrinkage per linear foot	.17 in.

Both bars were cast in the same position, and aside from the treatment mentioned all conditions were held as nearly alike as possible. According to theory our proportion of silicon in the second bar should be 11:17::X (or silicon in the second bar) :2.256 or X=1.459. You will note that this is .738 per cent less than the actual silicon contained. We are not surprised that Mr. Keep and the other exponents of this system are more or less prejudiced against chemists at large if they suppose that one-half of one per cent is the ultimate accuracy of their practical knowledge.

Let us look at the same case from the practical side. Supposing we knew the silicon of the first and second bar and the shrinkage of the first, to find the shrinkage of the second. 2.256: 2.197::X (or the shrinkage of the second bar) : 11 (the shrinkage of the first) or X=.15

Suppose this iron were being used in a 24-foot cylinder flanged at both ends, then the error in estimating the shrinkage would almost be one-half of an inch or enough to insure both flanges shrinking off. And yet in the face of all this it is claimed that the physical test system is economical. Let us take a glance at how such saving would result from the use of this system in a shop casting one such cylinder in a flask every day. From our previous observation we see that if the rule were adhered to our casting would be lost regularly, and counting $10 as the total cost other than metal for such cylinders, we would have in one year of 310 working days $3,100 lost on the work alone, or enough to maintain a chemist and laboratory in opulence.

No doubt Mr. Keep will say that if the first casting is lost through shrinkage, any one would use more soft iron. In that case his system becomes but a means of guessing and not an accurate, scientific method. When capitalists' millions and all of the employment resulting therefrom are submitted to the chance of a guess, no theory that maintains such a performance can be called a discovery or its constant use be honored by the name of a system.

When it is stated that it was discovered that shrinkage varied inversely with the quantity of silicon contained in the metal, it should be known that the discovery was only partly made. The facts are that shrinkage varies directly as the ontent of sulphur, manganese, combined carbon and titanium, and inversely as the silicon and phosphorus content. However, this variation is in no case in a true ratio, since the more of the affecting metalloid the iron contains, the more is its action facilitated or hindered as the case may be.

*Read at the Fall meeting of the Western Foundrymen's Association at Cincinnati, O., Oct. 18, 1897.

We suppose that all will acknowledge that each foundryman should strive in every way to better his profession. If it were not for this constant groping after the truth and the actual facts, what would cause the large attendance at the meetings of the associations? In connection with this desire for facts, please think of two foundrymen, one possessing a laboratory and chemical facilities and the other with a testing machine, price $200. The first through constant experiment and careful analysis would soon become a master of his trade, while the other would be bound completely by the rules of the system he was using. He would be forced to bid only for work such as he had made, since he would be unable to form any idea of the requirements or cost of new work. While the first could be constantly cheapening his process and adding to his store of metallurgical knowledge, the second could never make any discoveries or advancements in mixing his metals. Let me give an example taken from fact of the actual utility of chemical facilities. A foundry never before having made alkali kettles wished to bid upon such work. A sample of an old kettle was obtained and analyzed. The work was secured and 15 ten-ton ketles made without a single loss. Such facts speak for themselves and show conclusively the actual value of scientific methods as applied to practical industries.

Of all the discoveries that have been made in recent years in iron metallurgical work there has been only one that a foundryman equipped with a mechanical testing outfit could possibly have made and it is a noticeable fact that even this was made by a chemist. I refer to Mr. Outerbridge's discovery; and here it would be well to observe that facts are found out and discoveries made only after patient, methodical, intelligent toil, and are very seldom, if ever, the results of lucky guesses or haphazard work. Doubtless had it not been for his chemical research along the line of his discovery Mr. Outerbridge never would have arrived at the conclusions which have made him so justly famous.

Before leaving this phase of our subject, let me cite another instance where chemical science scored a point that mechanical testing never could have made. While using high manganese irons we found that our test-bars made from these mixtures invariably broke, higher than a corresponding mixture of low manganese metal. Scores of analyses were made to prove the cause of this phenomenon and in every case high mangaense was shown with no other phenomenal feature. Low manganese irons were tried having enough ferro-manganese added in the ladle to place the content of this element over one per cent. The results were the same as if originally high manganese iron had been used. The two test bars given below will show for themselves the advantage of gain in ultimate strength to be made in this manner. Both bars were cast on end and broken 36 inches between supports on a Riehle machine having the load applied at the center with a uniform acceleration.

First bar:

928 pounds breaking strain.
88.100 of an inch deflection.
.971 inch thickness.
.13 inch to one foot shrinkage.
.950 inch width.

Its analysis was as follows:

Silicon	1.98 per cent.	Sulphur	.050 per cent.
Phosphorus	.558 " "	Manganese	1.002 " "

This bar had a small amount of ferro-manganese added in the ladle, the iron being held until it flashed strongly before pouring.

Second bar:

736 pounds breaking strain.
.97 inch deflection.
.988 inch thickness.
.12 inch to one foot shrinkage.
.990 inch width.

The analysis of this bar was practically the same as of the first except in manganese, which was .712 per cent. It was also a plainly noticeable fact that the chill was less deep and the grain more uniformly close. As far as known this work was original with the author, and although the gain in strength and diminished chill was so great no detrimental qualities were given the iron except the increased shrinkage which was directly due to the increase in combined carbon, which the metal took from the ferro-manganese.

Hundreds of corroboratory bars and other tests might be given, but these will prove the correctness of the statements made as well as any evidence could. In connection with manganese and its influences upon chill it will no doubt be interesting to know that many car-wheel foundries are using ferro-manganese to keep down the chill, and thus are at liberty to use greatly increased quantities of remelt in their mixture and very little pig metal. The ferro-manganese is added in the ladle as described and as much remelt carried as 85 per cent. The action of the manganese seems to be to increase the combined carbon and to eliminate the sulphur. The first effect will be readily explained by the analysis of ferro-manganese which will run about as follows:

Manganese	80 per cent
Combined carbon	8 " "
Iron	12 " "

The second or eliminating action has as yet not been satisfactorily explained although it is known that preferentially sulphur combines with manganese instead of iron. It is known, however, that the action is greatly facilitated by the presence of a basic slag and all metallurgists who have investigated the science of metallography agree that no pig metal even when cold is free from slag, so that when liquid, its presence is almost certain. Presuming this to be the case, the reaction would take place as in the basic steel furnace; the sulphur of the iron sulphide combining with the manganese and again combining with whatever base of the alkalies or alkaline earths that might be present. In cooling, this slag would naturally separate itself from the metal in a larger degree, and hence its method of eliminating sulphur.

While speaking of the relative value of physical tests, it may be interesting to consider briefly their worth as absolute measurements of the qualities of various materials. It will be understood that the value of any test is in a direct ratio to the similarity of composition and structure existing between the test piece and the finished product whose qualities are sought. Since Bessemer steel is more homogeneous than most other grades, tests taken from it are far more correct and more closely approximate the qualities of the heat than those aken from open-hearth billets. However, in the best Bessemer ingots the segregation of phosphorus is so great that tests taken before the metal has passed through the mill, are of little absolute value. How much greater then must be the chance of error in determining the qualities of cast iron which has been melted in a cupola, where the more fusible components of the iron mixture melt, and are tapped out leaving the more refractory to come out at some future tap.

It has been common experience in one of the large foundries that the first tap of the day was uniformly softer than that of any other time during the heat, when the same mixture was being charged on. A few analyses upon this point taken on three successive days may be of interest.

FIRST METAL TAPPED OUT.		METAL FROM FOURTH TAP.	
Silicon	2.739 per cent.	Silicon	2.102 per cent.
Silicon	2.89. " "	Silicon	2.007 " "
Silicon	2.624 " "	Silicon	1.992 " "

In connection with what has been written of late upon the comparative fusibility of hard and soft metals, these analyses seem to bear valuable testimony. The author's intimation in a previous paper that invariably hard metals would fuse at a higher temperature than soft ones has been severely criticised. Lack of time has been the only cause for not making a number of experiments upon all brands and grades of metal to establish the truth in regard to this matter. However, the analyses given would seem to strongly support the author's theory, and it has been without exception our experience that regardless of the combination of metalloids, silicon is the most potent factor in determining the temperature at which cast iron melts.

Before concluding, one means of physical testing which has demonstrated its merit must be mentioned, and that is the microscope. The invaluable work which has been done in the last year by the foremost investigators in the field of iron metallography has made the microscope in the hands of the experienced and competent metallurgist, a neccessary adjunct to every progressive steel mill and iron foundry. The discovery and isolation of martensite has cleared away the mists of ignorance and doubt concerning the cause of the famous phenomenon of Gorè. It only remains for the chemist to settle forever the dispute of the eminent microscopists, Osmond and Howe, as to whether this martensite is an allotropic form of ferritic iron or but a kind of iron carbide, and if so to determine its composition. Personally it may be said

that we have been using a microscope in our laboratory for the last year and it has given perfect satisfaction. The longer it is used the more necessary does it become and the more valuable does it prove itself to be.

The elaboration of the knowledge of the world upon the constituents of iron and its consequent physical properties has proved to be of great commercial value. For instance, in determining what iron to use in dynamo field castings, the amount of ferrite contained in the iron proves to be in proportion to the number of lines of forces per unit area that the metal will carry. Some pearlyte and cementite should be present, however, in order that the fields may possess the proper amount of residual magnetism. This shows one application of technical scientific knowledge to industrial work.

In conclusion it may be stated that the commercial value of a laboratory will be in direct proportion to the liberality of its equipment and to the competency of the operators employed. Physical tests will be found valuable only as they are made on reliable apparatus, and it may be put down for a fact that no system of testing or any machine will ever be equal to the ingenuity of a trained and competent man, situated with such facilities at his disposal that he may use his knowledge to the best advantage.

MOLDING SAND.*

BY D. H. TRUESDALE.

In these progressive days when there is a constantly growing demand for castings of a better quality, and foundrymen are striving in every way to make better work, and in many cases failing to produce satisfactory results, it seems proper to call your attention to what I believe to be one of the most prolific sources of failure.

Molding sand being the most important factor in the production of good work, it follows that it is of the greatest importance that the utmost care should be taken in selecting sand that is the most suitable for the work to be made. At the same time it is important to obtain a more thorough knowledge of the elements of which the best sand is composed.

The first thing to be taken into consideration is what are the necessary elements of molding sand, and in what proportions should they be combined. There are four qualifications that are absolutely necessary; these are, refractory qualities, porosity, fineness and a sufficient bond. Let us take these up in the order named.

First, refractoriness: The element which possesses this quality in the greatest degree is silica. Silica is found to be a component part in all the sand that is furnished to the foundrymen, but often in such small proportions that the sand is absolutely worthless. Being practically non-fusible, it follows that sand containing the largest percentage of silica that it is possible to work will give the best results. Only sufficient alumina should be present to form a perfect bond in connection with the water necessary to make the bond complete.

My experience in the foundry business having been altogether in the line of light castings, such as stove plate, hollow ware, and work of a similar character, I shall confine myself to what I believe to be the best sand for work of that class.

I take it to be self-evident that the only properties necessary in molding sand are silica and alumina. The presence of lime, magnesia, metallic oxide, etc., are detrimental. Of course I know that it is practically impossible to get sand with just the proper amount of silica and alumina in combination. To remedy this trouble, I have found the best way is to make the mixture yourself. To do this in a practical manner all that is necessary is to get the pure silica, or as nearly so as possible—and it can be had up to 95 percent pure—and mix with a fine strong sand containing at least 60 to 70 per cent alumina. It is impossible to give the exact proportions it would require in each case owing to the variation in the sands that are found in different parts of the country. Theoretically, the proper proportion of silica is 90 per cent to 10 per cent of alumina, but it will be readily seen that these proportions are, in the every-day hurry and push of the modern foundry, very difficult to keep up, as the clay in the strong, fine sand, vitrifies, and adheres to the castings each day, so that the proportions would be changed after each heat.

I have found from practical experience that from 33 to 40 per cent of silica with such sand as I spoke of before, gives the best results, making castings with a smooth surface and sharp lines, and also, what in my estimation is of greater importance, enabling the foundryman to dispense to a very large degree with the use of foundry facings.

There are on exhibition here some specimens of "art" castings, also some ordinary stove plate made in the manner spoken of, that will speak for themselves, which you are invited to examine.

Second, porosity: It is hardly necessary to say much about this, as every one understands its importance. It will be found that by the use of silica, owing to the crystal formation of the particles, this property will be preserved to a degree that will in a great many cases render venting unnecessary. I have seen large and intricate castings that have been considered hard to make, owing to the difficulty in venting them, made with complete success without the use of a vent-wire, which result was brought about solely by the use of silica sand.

Third, fineness: This is a matter for which there can be no rule, as the term fine sand is a very indefinite one. What one foundryman terms fine sand another would pronounce coarse; so the question of a proper degree of fineness must be left to individual judgment, in accordance with the work to be made. I wish to say, however, that in my opinion a proper use of silica will enable the foundryman to use sand that is much finer than is commonly supposed possible on medium heavy work, thereby making castings with a better surface than with coarse sand.

Fourth, bond: By this is understood that constituent which joins and holds the particles of silica together during the process of pouring. For this alumina or clay is found to be the best, as silica, having absolutely no adhesive powers by itself, must have some material possessing the adhesive or "sticky" property necessary to hold the particles together while the mold is being filled. No more alumina or clay should be present than is necessary, as any increase over the proper percentage makes bad, rough work by its melting and adhering to the castings, causing extra expense in cleaning, and at the same time incurring the liability of loss; in many instances causing blow-holes owing to the increased density of the mold, thus preventing the rapid escape of the gases.

As we have to use water to complete the bond and depend upon it to keep the mold intact, while being poured, it follows as a matter of course that the sand that will stand the use of the greatest amount of water is the best sand. In all cases as much water should be used as possible and at the same time prevent "blowing."

A judicious use of more silica in the sand will convince any foundryman of its value, and once having proved it, no backward step is likely to be taken.

The ideas presented in this paper are solely the result of several years experience in the use of silica sand, after having proven to my complete satisfaction its value in the production of good castings.

There is another feature in connection with silica that I have not spoken of, but it is well worth considering, that is its use in making cores. It will be found on trial, that cores made with it alone and oil, will result in smoother, cleaner castings than any other core sand, at the same time dispensing entirely with "core wash" of any kind, as the refractory powers of silica absolutely prevent any burning of the sand, causing the core to fall out at the tap of the hammer, leaving a very smooth, clean surface, better than I ever saw by the ordinary way of making cores. Also the sand can be used over again indefinitely, as it is in no way injured or changed by having iron poured on it, except to be discolored by the burning of the oil, which does not alter its value. I have tried this repeatedly and know from experience what I say is true. A trial will convince any one of the fact.

I cannot but believe that a more thorough study of the value of silica in molding sand will yield what all engaged in the business must admit is greatly to be desired, that is, the production of better and smoother castings, resulting in economy in cleaning, finishing, etc, as well as gratifying the pride of every true foundryman.

*Read at the Fall meeting of the Western Foundrymen's Association at Cincinnati, O., Oct. 20, 1897.

THE MELTING OF IRON IN THE REVERBERATORY FURNACE AND THE CUPOLA.

BY E. H. PUTNAM.

If the young man wishing to learn iron founding so as to become a foreman could be sufficiently impressed with the importance of a thorough knowledge of the art of melting iron, his progress would be much more rapid and his success far surer. Many a first-class molder has utterly failed as foreman simply because he could not melt iron successfully. One of the chief hindrances to the progress of the novice is the marvelous melting done (on paper) by some modern foundrymen. The young man thinks he must melt 12 or 14 to 1 or "burst," and so he—bursts!

Don't do it, my young friend. Use enough fuel to insure hot iron at every tap, from first to last every day in the year; and, other things equal, your per cent of good castings, in excess of your competitor's who melts 14 of iron to 1 of coke will pay for all of the coke that both he and you use.

The melting of iron is indeed a great art, and the furnaces employed therein have been of many various designs; but probably the best of all is the reverberatory furnace. True, the cupola is usually preferred for ordinary castings, simply because it is the cheaper, and the castings produced therefrom, though not the best, are nevertheless acceptable. But, on the other hand, in certain classes of product, the matter of quality outweighs the question of cost; and then the reverberatory furnace is used. Sometimes both styles of furnaces are used in conjunction; as when the cupola will not hold sufficient iron for a large casting. Then, the reverberatory furnace, heated by firing, as usual, becomes the storage receptacle of the molten iron tapped into it from the adjacent cupola. Here the iron is kept hot till enough has been accumulated for the casting required. Though the reverberatory furnace is employed in the melting and refining of all sorts of metals, yet its principal function is in the melting of cast malleable iron. Though the cupola is often used with advantage in this very important branch of iron founding, yet where great ductility and strength are required, the reverberatory furnace should always be used, as it unquestionably produces iron of a quality much better than that from the cupola. That is, it is more nearly perfect in homogeneity; it is much stronger, and it may be bent and twisted, after annealing, much more than cupola malleables would bear. This fact does not however utterly condemn the cupola as a melter for malleables, because there is a very large class of castings that are for all practical purposes quite as good for having a strength intermediate between that of gray iron and the strongest malleables. For this reason a great many manufacturers of cast malleables employ both kinds of furnaces. And some use two kinds of reverberatory furnaces—blast and natural draught furnaces. I am of opinion, however, that the natural draught furnace is not often seen, at least in the United States; for Yankee push will not forego the use of an accessory that makes fair speed.

Reverberatory Furnace Construction.

There have been tried many modifications of shape, and of proportion in the construction of the furnace, in order to economical melting. The first desideratum is, of course, hot molten iron; then economy of fuel. To this end the sectional area is greatest at the hearth, and diminishes rapidly toward the stack. A few years ago, all of the blast was introduced by way of the ash pit, through the gratebars. But this does not produce perfect combustion, a large amount of fuel in the shape of smoke escaping through the stack.

To remedy this, air is projected in from above at the bridge-wall, or furnace, end of the hearth. This portion of the blast enters through a number of small pipes, say, three inches or four inches diameter, whose longitudinal direction is such as to deflect the heat down on to the iron in the hearth. Thus, this added blast of atmospheric air produces more nearly perfect combustion, and tends to direct the heat to where it is most needed.

The bed, or bottom of the hearth, is composed of fire sand. The toughness of this course-sand bed, after firing over it for a couple of hours, is remarkable. The fire vitrifies the sand, but does not melt it. The hearth, therefore, becomes an unbroken and unbreakable floor upon which the heavy pigs of iron may be thrown without any danger of their breaking through.

The hearth, or portion of the furnace containing the iron, is lowest at the section where the tap hole is located, midway between the bridge-wall and the opposite end, the depth being governed by the disposition of the fire sand. The depth is determined by the quantity of iron that is to be melted. The hearth should be always as shallow as convenient for the amount of the "heat" or charge, so as to hold the iron well up against the action of the flame. The cope of this style of furnace is constructed of "bungs," so-called. A solid arched top would not answer because the heat is so intense that the bricks would frequently cave in, in various places, and then, in order to repair, the whole roof or cope would have to be torn down. This would make simply an unbearable expense. The bung is a skeleton frame of sact iron filled with fire brick set on edge and held in place in the frame by means of a bolt which traverses the whole length of the bung and projects through a washer at each end. This washer is so adjusted as to press against the outer brick at each end of the bung, the nut being turned by a heavy, long wrench. The bricks are of the oblong shape, commonly called square. Their faces should be rubbed together till they fit closely; then they are dipped in a batter of fire clay, and set in place. There is but one row of brick to each bung, and the bungs are set side by side across the furnace till it is completely covered. After the furnace has been fired for two hours, more or less, a few of the bungs are removed from about the middle of the furnace, the charge of iron is thrown in and the bungs are then replaced. All cracks or appertures should be carefully stopped with mud. A few extra bungs should always be kept ready so that, if in the progress of a heat, any one or more of the bungs should give way, as indeed they sometimes do, it can be replaced without loss of time, or waste of heat. Just outside of the furnace, in the floor under the tap hole is a good sized pit partly filled with dry gangway sand. This is a very important feature, and, though I have seen a furnace without it, yet it ought under no circumstances to be omitted. For the iron is apt to get away at times, and when there is no pit, it runs all over the floor, compelling the workmen to run away, burning the man who is trying to stop the tap hole and perhaps finally getting the advantage and taking its own extravagant way till the furnace is emptied. But with the pit, if the stream of iron gets a momentary advantage, still, as the iron falls down into the dry sand in the pit, it is at once covered from sight—there is no danger of its burning any one, and everybody knows it and so no harm is done. The walls of this pit are simply four cast iron plates set on edge. When the bull ladle is used the shank rests upon the end plates, which should rise somewhat above the floor.

Quality of Iron to be Used.

A different grade of iron is used in the reverberatory furnace from that which is chosen for the cupola. The iron which comes from the cupola is, approximately, the same grade that went into it. But that which comes from the reverberatory furnace is of a distinctly different grade, sometimes widely different. Iron melted in the cupola is drawn from it practically as fast as it melts. But the iron that is melted in the reverberatory furnace remains under the action of the fire until all the charge is melted, and has become sufficiently hot and fluid for casting. This protracted firing burns away the silicon to a greater or less extent, thus rendering the carbon less apt to separate into the graphitic form in the casting. Of course this also takes place in the cupola, but to a very slight extent. So in making malleable iron from the cupola the mixture of iron put into it is, as to combined carbon, nearly what it will be after melting. In the reverberatory furnace a mixture is used whose proportion of combined carbon, is, before melting, very greatly less than it will inevitably be by the time it is sufficiently hot for casting.

In the making of malleable iron castings, the carbon should be combined with the iron to such an extent that no graphitic carbon may be seen in the fracture of the casting. That is, the carbon should be wholly in the combined state. And the mixture of irons for either style of furnace should be, to speak popularly, as soft as possible, consistent with this result. Any

further firing or hardening is injurious, rendering the annealing more difficult.

Iron having the carbon in the combined state has a white fracture, is very hard, brittle and weak. Extract the carbon from this iron and it will be very soft, ductile and strong, and of solid structure. Iron having the carbon in the uncombined, or graphitic state, is soft and strong to a degree; that is, it is simply common gray iron. Extract the carbon from it and it will be a weak, cellular, worthless mass, because the graphitic carbon lies in interstices of the iron. Therefore, in order to benefit iron by extracting the carbon, the latter must be first chemically combined with the iron, when its removal will leave no pores or spaces between the particles, or atoms of iron.

Iron for Chilled Castings.

In making chilled rolls car wheels and other chilled castings, the desideratum is to have the carbon in the combined state in a portion of the casting only. While it is true that malleable cast iron before annealing is almost, if not quite, as hard as chilled iron, yet the hardness is merely incidental, resulting from the, purposed, combination of the carbon. I may as well here state that chilling is also very frequently employed in malleable iron manufacture for the purpose of combining the carbon by rapid solidification in heavy portions of the casting; also in angles, where otherwise the shrinkage would cause a "crack" or separation of the iron crystals. For shrinkage is invariably from an angle in at least two directions, if no chill is used. But suddenly solidifying the iron at the angle by means of the chill causes it to contract at the time when it can draw freely from the surrounding fluid iron, and therefore no fracture results.

Combination is effected in malleable iron in order that the carbon may be extracted without leaving any porosity; thus producing a soft, strong iron; but in chilling the combination is effected with the express object of hardening. Fortunately, also, the chilling process causes the iron crystals to arrange themselves longitudinally perpendicular to the surface of the casting. This presents a surface of the utmost uniformity of texture and of the least possible porosity.

Iron comes from the smelting furnace in six or seven distinct grades, each grade varying in composition, so that any desired mixture may be formed by the educated manipulator. Uniformity of the mixture is of high importance generally, and in malleable and chilled castings especially. And this is emphatically true in the case of chilled rolls.

While either the cupola or the reverberatory furnace may be used in this work, yet undoubtedly the higher degree of perfection may be attained with the latter. I will not go so far as to say that this degree of perfection is always essential. Perfection is the costliest thing known to the mechanical world; and even an approach thereto is more than the average buyer is willing to pay for. In deciding as to the expediency of employing a mechanical process, the first necessary question is, will it pay?

To operate a reverberatory furnace economically there must be three heats a day; and it would take a pretty good sized business in this specialty to permit of this. However, the art of melting iron in the cupola has advanced so rapidly of late years that the objections that formerly stood against this method have been largely stripped of their importance. The chemical changes necessary in the production of malleable cast iron render the reverberatory furnace almost indispensible in that branch of founding. But these do not obtain in like degree in the manufacture of chilled rolls and of chilled castings generally. The skilled founder of chilled iron castings can be sure, therefore, of a product from the cupola of such uniformly excellent quality as to render him properly indifferent to the claims for the reverberatory furnace.

Cupola Management for Chilled Work.

It is not only possible, but it is easily practicable to produce from the cupola a uniform grade of iron day by day the year around. And this is the essential thing in making chilled castings. In the first place, the sand bottom in the cupola should be dry. But the question arises, What is meant by the word "dry." Well, it is rather difficult to define. It should not have sufficient moisture to cause the slightest danger of scabbing, or of making the molten iron boil. It should not be packed with a rammer, but should be trodden to moderate compactness with the feet. This will make possible the easy escape of the steam and gas through the sand and out of the cracks between the drop doors and the iron bottom. Then the fuel for kindling the fire should be dry. I have known wet kindling wood to change naturally soft gray iron to perfectly white iron. The walls of the cupola at the melting zone should present a fire brick surface and not a wet, mud surface. Sand stone spalls, or any sufficiently refractory material may be used for repairing, instead of fire brick, if desired. After "trimming out" the cupola, throw thick, heavy mud, preferably of fire clay, into the space to be repaired. Then carefully imbed the fire brick in such a manner as to present as little mud surface as possible.

The sum of area of tuyeres should exceed that of the blower outlet by about 50 per cent. This, in order to compensate for the greater frictional surface and for the partial obstruction by the fuel. The coke used should be the best foundry coke and the bed should have sufficient depth to insure hot iron at the first tap.

The proportion of fuel to iron thereafter should be such as to insure hot iron at every tap—which is equivalent to stating that you must not try to melt 12 lbs. of iron to one of coke. For, though it is generally claimed that hard iron melts at a lower heat than soft iron, yet it cannot be claimed that it "stays melted" so long as soft iron. That is, a greater heat is required to make it fluid. Homogeneity is essential in chilled iron and extreme fluidity promotes this.

The size of the pieces of iron that enter the cupola should be proportioned to the size of the latter. This is far more important in chilled iron work than in ordinary casting. The mixture must be right, and if the pigs are long enough to cause any clogging of the cupola, a perfect mixture will be impossible. Let the fire burn through the bed of coke, and immediately charge the iron. Keep the cupola full to the charging door, till all the stock for the heat is on.

Provide a cupola ladle that will hold at least one charge of iron and tap into this till nearly full, before taking away the pour. This should give a pretty good mixture of iron. If you attempt to do without the cupola ladle and tap directly into the small pouring ladles, a portion of the iron may be too hard and another portion too soft. In charging the cupola, do not make the charges too large or the mixture may not be thorough.

The cupola should always be charged by a written formula and that formula should be kept, at least for a time, to refer to in case a change is desired. Every time the cupola ladle is filled a test casting should be made before the ladle is quite full, and this, cooled by plunging in cold water, should be broken, to ascertain if the chill is of the right depth. If too hard or too soft, tap into the ladle again before pouring and, if the mixture charged was right, your cast will also probably be right. By examining the test casts closely, any corrections desired may be made from day to day.

In conclusion, I will say that three or four different irons in a mixture, always including a liberal per cent of scrap—say 40 or 50 per cent—are much better than a less number of different brands. If there is a bad quality in one of the brands, not so much of it enters into the mixture, and the qualities of the other brands tend to neutralize it.

However, a good mixture may be made of two irons, and the current product of scrap and sprues provided the two irons be not too diverse in grade. Do not try to make chilled castings from all coke iron. But, having a good charcoal iron to rely upon for chilling tendency, modify that tendency by the use of some coke iron, if you choose.

Bids for the plant of the East Chicago Iron & Steel Co., of East Chicago, Ind., were called for by Receiver A. M. Turner on Oct. 12, but none were received, and the plant is still unsold. It is said an understanding was had between intending bidders that no bids should be put in until the court reduces the minimum purchasing price, which was set at $50,000. It is understood that the creditors will petition the court to do this.

We are authorized to state that the report that Rogers, Brown & Co. have leased the property of the Valentine Iron Co., at Bellefonte, Pa., with the intention of operating the plant is not correct.

THE MANUFACTURE OF EMERY WHEELS.

It gives *The Iron Trade Review* pleasure to present some half-tone illustrations and some descriptive detail of the process of manufacturing emery and corundum wheels, as carried on at the plant of the Sterling Emery Wheel Mfg. Co., of Tiffin, O. This company is a leading, if not the foremost, manufacturer of abrasive appliances in the country.

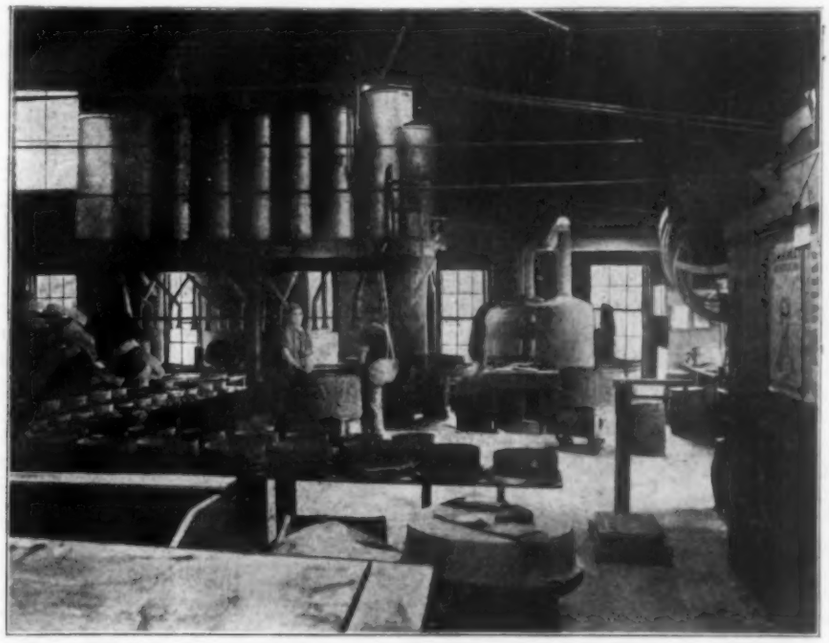

FIG. 1.—MIXING DEPARTMENT.

Emery and corundum are practically the same abrasive, for the part of the emery that does the work is corundum. Emery is a mixture of corundum and the so-called oxide of iron, the percentage of the latter sometimes running over 50. Emery is mined in Asiatic Turkey, in the Island of Naxos, and in Chester, Mass. The Chester emery has a larger percentage of corundum than the foreign emery. Corundum is found in commercial quantities only in North and South Carolina and Georgia, although there is some of it in Alabama and Eastern Tennessee. Corundum, being free from an excessive percentage of foreign matter, possesses much greater polishing and grinding qualities than emery. In the arts and sciences corundum is rated next to the diamond in hardness, and after it comes emery.

Both emery and corundum are prepared for use in about the same way. They are crushed down to different degrees of fineness, and after being cleaned are graded in different sizes, ranging from No. 6 to the finest flour. These sizes take their names from the number of meshes to the lineal inch of the wire cloth through which they are graded. The coarser sizes are used most in making emery and corundum wheels.

The principal reason for using more emery than corundum is the difference in cost. Miners of emery ore in Turkey receive but six or seven cents per day, while the minimum wages paid to miners of corundum in this country is not less than 70 cents per day. Emery ore is brought to this country largely as ballast, and the cost to land it is therefore about one-twentieth the cost of transporting corundum from the mines to the same points in this country.

FIG. 2.—DRAWING A KILN.

The bond or cement holding the grains together in both emery and corundum wheels is practically the same. An

emery wheel is made of such diameter and thickness as will best suit the work required of it. It is made in different degrees of hardness, some work requiring a soft, some a medium and some a hard wheel. It is also made of different sizes of emery grains, according as the work to be done is coarse or fine.

The chief uses of emery and corundum wheels are to finish up and give a smooth surface to iron, steel or other metallic substances, stove castings, agricultural implements, machinery, tools, cutlery, etc. Large quantities are used, as is well known, for gumming saws and grinding planer knives. In fact, they are sometimes called rotary files. But grinding, polishing, sharpening and shaping metal and wood substances do not cover all their uses. The Sterling emery wheel works have made wheels for grinding feathers. Emery also does the work similar to that required of the planer and lathe. It is claimed, indeed, that the uses of the emery wheel can be so varied and developed that the business is really but in its infancy.

There are already such a variety of grades, shapes and sizes in use that it is impossible for any manufacturer to carry a full stock, and most orders have to be made up after they are received. Few buyers understand this fact, and orders are not placed as far in advance of needs as they should be; and buyers often fail to allow for the time necessary to make a wheel properly.

The three classes of emery and corundum wheels are known as "vitrified," "silicate" and "chemical." The "vitrified" wheel, of which there are the most in use, is burned in kilns. The "silicate" comes next in quantity used. It differs from the "vitrified" in the bond used to hold the particles of emery and corundum together; in being molded and tamped in molds instead of being cast in just the sizes required; in being baked in ovens for a much shorter time and at not near as high a heat; also in that it can be made with or without a wire web. The Sterling Emery Wheel Mfg. Co. makes both the straight "vitrified" and "silicate" wheels, and also a semi-vitrified "silicate" wheel, which combines the best qualities of the other two.

FIG. 3.—TRUING AND TESTING ROOM.

FIG. 4.—TAMPING THE MIXTURE IN MOLDS.

Referring to the illustrations of the principal departments

of the plant of the Sterling Emery Wheel Mfg. Co., at Tiffin, O., view No. 1 shows the mixing department, the large tanks at the rear containing the different numbers of emery and corundum. A weighing appliance is underneath each, thus allowing the mixer to draw such sizes and quantity as is needed for the mixture. The wheels, after being mixed, are put in a dry room for one night. In the next room, the shaving department, the vitrified wheels are shaved down to nearly the required size, leaving just enough allowance for contraction in burning. They are then placed in a large dry room and remain there until thoroughly dry before being placed in the kilns. Illustration No 2 shows the kiln men drawing a kiln, the wheels having been subjected to a heat of between 2,500 and 3,000 degrees for about 72 hours, thus becoming thoroughly vitrified and one solid mass.

The next process is shown in Fig. 3 where the wheels are trued up and turned to exact size They are then tested at a speed giving them a working strain of more than double that at which they should be run when in actual use. Besides this test every wheel is tapped by an expert with a hammer the last thing before being packed for shipment, to make doubly sure that no unsound wheel leaves the factory. Moreover, every emery wheel should always be tapped in this way just before it is placed on the machine for use, as it is not unusual that a wheel is so handled in transit that a latent crack is started, which does not manifest itself until the wheel is in actual use. Another pertinent fact is the statement of an Ohio State inspector of factories that he found in at least nine cases out of ten, where emery wheels were broken, in the hands of the user, that the breakage was caused by the working man in putting the wheel on the machine.

Fig. 4 shows the principal process in the manufacture of the "advance safety" or "silicate" wheels made by the Sterling Emery Wheel Mfg. Co The men are at work tamping the mixture into the molds. This requires skill and experience on the part of the molder, as he must get the mixture in equally, and in such a way that the wheel will be of the same hardness through and through, and hence run true and cut uniformly. In the center of this wheel a wire web is placed when so desired. After the wheels are molded to a proper size, they are baked in the oven shown at the rear of the illustration. They are then taken to the turning department, illustration No. 3, where they are trued up and tested by the same process as in the case of the "Sterling" or "vitrified" wheel.

The factory of the Sterling Emery Wheel Mfg. Co. is so arranged that the raw materials come in at one end, and proceed by regular stages to the other end, where the finished product is packed for shipment. The shipping facilities of the concern are excellent Side tracks extend on both sides of the factory and direct connections are made with the numerous trunk lines reaching Tiffin.

In addition to the growing home demand, which has made the business at Tiffin a steadily increasing one, the company is building up a fine foreign trade, the reputation of its products abroad, as well as at home, being of the best.

THE Philadelphia Commercial Museum has established a laboratory of tests and technology as an adjunct of its scientific department. Its main object is the examination and analysis of raw and manufactured products sent to it by manufacturers of the United States or from any of the countries represented in its collection. It was started because of the constant receipt of ram products requiring analysis to demonstrate their availability for American manufacture.

THE foundry and machine shop of the Frank-Kneeland Machine Co., Pittsburg, have already felt the revival in trade and have been running for some time to their fullest capacity. Among recent orders are a universal mill, transfer tables, shears, etc., for the Granite City steel department of the St. Louis Stamping Co.; 26-inch sheet mills, shears, etc., for Reeves Iron Co., Canal Dover, O.; addition to Pennsylvania Tin Plate Co.'s plant, at New Kensington, Pa., consisting of two 26-inch hot mills, two 22-inch cold mills, and doubling and squaring shears. A large lever shear with 14x16 engine attached, for cutting four and a half inch square steel, is just being completed for the Monongahela Furnace department of the National Tube Works Co., making the second shear of this size furnished that company. Other orders for shears, sand and chilled rolls, general castings, etc., have been received.

RECEIVED FROM THE TRADE.

The Moore Mfg. Co., in sending out some fresh literature concerning its chain hoists, steel door hangers and rail and other specialties, announces its removal from Milwaukee to the works of the HP Nail Co , Cleveland, and that all mail should be addressed to it at Cleveland.

A late leaflet of the Harrison Safety Boiler Works, of Philadephia, contains an illustration showing the pipe connections to a Cochrane special heater or receiver. It is offered as a suggestion of simple, practical piping, but the circular adds that the designer of the steam plant can attach any system he desires and get excellent results from the Cochrane heater. They are built for a working pressure of 15 pounds per square inch.

General catalogue No. 28 of Henry R. Worthington gives several impressive proofs of the magnitude of the business so long conducted under this name. The Worthington hydraulic works were established in 1845 and from the first have been devoted solely to the manufacture of pumping machinery. Over 100,000 pumps, hundreds of them being of the largest capacities built, have been put out at the Worthington works and the annual capacity to-day is 14,500 pumps. Of the triple expansion, high duty compound and high duty triple expansion forms, more than 260 have been built for water works in various parts of the world. Up to Aug. 1, 1897, their aggregate daily pumping capacity was over 1,600,000,000 gallons and the aggregate daily capacity of all the Worthington pumping engines in water works service was over 4,150,000,000 gallons, equivalent to 2,880,000 gallons a minute. There are 110 pages of half-tone illustrations and details, the larger portion being taken up with descriptions of pumps; then follow in turn illustrations and descriptions of the Worthington condensers, steam accumulator, marine feed heater, etc.

The Gobeille Pattern Co., Cleveland, gives food for thought in one of its most recent circulars. Starting with the assertion that "because of good times, old concerns will go behind and newer ones will forge ahead" it suggests that if the reader will make a list of the past presidents of the National Association of Stove Manufacturers, the six leading stove manufacturers of 1877 and the six leading stove manufacturers of 1897 something will strike him. Making the point a little plainer, the statement follows that reputation, good will and long and honorable business career count for little unless a concern constantly caters to the public in the matter of patterns. Then comes the application, which the reader is apt to guess before he reads it.

Bundy steam traps are the burden of a little special catalogue, pocket size, issued by the A. A. Griffing Iron, of Jersey City. Illustrations of these traps in various services are given, and facsimiles of awards received at various home and foreign expositions.

Jas. L. Robertson & Sons, successors to Hine & Robertson Co., 204 Fulton st., New York, devote a recent catalogue to the Robertson shaking and dumping grate bar. Engravings show the important features of its construction. The points emphasized are the ease and slight expense of inserting repair parts, the bars being a series of replaceable leaf castings, a best quality wrought iron cross bar protected from the heat, and double bearings, in which friction is reduced to a minimum. Seven years' tests are cited in evidence of efficiency and durability and recent changes in design have tended greatly to increased strength. The margin of the catalogue is devoted to a number of coal-saving devices manufactured by the company—the Hine eliminator, the Kellam damper regulators, Robertson's oil filter, exhaust head, steam separator and oil extractor, etc.

H. S. VROOMAN, dealer in molding sand, fire brick and other foundry supplies at 220 W. 20th st., Chicago, reports having had a very good business since starting up for himself, and that the prospects for an increase are excellent. Mr. Vrooman is well known by the foundrymen in the Chicago district, as he was for a long time connected with one of the foundry supply houses of Chicago as salesman, and was treasurer of the Western Foundrymen's Association at one time. His long experience as a salesman of foundry supplies insured the success he has had since embarking in business for himself. He handles a high grade of supplies which are giving satisfaction to his customers.

COMPARATIVE FUSIBILITY OF FOUNDRY METALS.*

BY THOS. D. WEST.

The first paper treating of this subject was read before the Pittsburg Foundrymen's Association, June 28, 1897, and was published in full by *The Iron Trade Review*, July 1, the August *Foundry*, the *Journal of the American Foundrymen's Association*, Vol. 3, Nos. 13-14, and London *Engineering*, Sept. 10, and reviewed by the *Engineering Magazine* for September. The first paper illustrated the writer's comparative fusion test cupola and gave among other things, a series of tests which prove that iron made hard by reason of low silicon and high sulphur will come down faster, or require less heat to melt it, than iron made soft by reason of high silicon and low sulphur, when the carbons are alike and all conditions are the same as regards the working of a cupola.

This paper, aside from presenting several important discoveries, shows that a chilled body of iron will melt faster and require less heat than a gray body, both having been poured from the same ladle or cast of iron, or in other words, being of the same chemical composition, aside from differences in the relative proportions of combined and graphitic carbon due to the rate of cooling. It presents a series of experiments proving that steel proper requires higher heat than cast iron to fuse it, and that remelting of steel in contact with incandescent carbon wholly destroys its original character.

Comparing the fusibility of gray and chilled bodies both of the same composition, was suggested by Dr. Moldenke, the experienced metallurgist of the McConway & Torley malleable iron works, at the Pittsburg foundrymen's meeting last June. To do this, the writer has designed the following simple plan: A heat of chilling or No. 3 charcoal iron, designated as heat No. 9, Tables 3 and 4 (the iron being furnished by Dr. Moldenke), is caught in hand ladles and then poured into sand and chill molds placed side by side. This gives a wholly gray body of iron in the casting coming from the sand mold and a wholly chilled or white, crystallized body of iron from the chill or all-iron mold, both, it is to be remembered, being from the same ladle of iron.

TABLE 3.—COMPARATIVE FUSION TESTS OF GRAY AND CHILLED IRONS.

Heat Numbers	9	10	11	12	13	14	15	16	17	18	19	20
Kind of metal charged.	Charcoal pig iron.	Sand and chill rolls.	Sand and chill block re-melt.	Sand and chill rolls.	Charcoal pig iron.	Sand and chill rolls.	Charcoal pig iron.	Sand and chill rolls.	High manganese and phosphorus charcoal pig iron.	Sand and chill rolls.	Foundry pig metal.	Sand and chill rolls.
Weight of iron charged each side of cupola	75 lbs.	48 lbs	44 lbs.	32 lbs.	70 lbs.	53 lbs.	77 lbs.	58 lbs.	68 lbs.	40 lbs.	73 lbs.	55 lbs.
Blast put on	1:30	4:06	3:38	2:23	1:10	2:30	1:05	1:47	3:49	3:56	4:22	4:25
Chilled iron running		4:13		2:35½		2:38		1:52½		4:01		4:35
Gray iron running	1:39	4:15	4:11	2:39	1:18	2:40¾	1:15	1:54	3:57	4:01¾	4:33	4:35½
Chilled iron all down		4:31		2:44		2:51		2:02		4:08		4:38½
Gray iron all down	1:47	4:32½	4:22	2:47	1:26½	2:52½	1:27	2:03	4:06	4:09¾	4:42	4:39¾
Chilled iron exceeded gray in starting		2 m.		3m. 30s.		2m. 15s.		1m. 30s.		45 s.		30 s.
Chilled iron exceeded gray in finishing		1m. 30s.		3m.		1m. 45s.		1m.		1m. 15s.		45 s.

*Read at the Fall meeting of the Western Foundrymen's Association at Cincinnati, O., Oct. 19, 1897.

TABLE 4.—CHEMICAL ANALYSIS AND SPECIFIC GRAVITY OF GRAY AND CHILLED IRONS.

Heat Nos.	9	10		11		12		Analysis of castings obtained from the 12th heat.			
Kind of metal charged	Charcoal pig iron.	Sand rolls.	Chill rolls.	Sand rolls.	Chill rolls.	Sand rolls.	Chill rolls.	Sand rolls.	Chill rolls.	Sand rolls.	Chill rolls.
Analysis letter	A	B	C	D	E	F	G	H	I	J.	K
Total carbon	3.94	4.10	4.06	4.30	4.30	4.47	4.40	4 68	4.62	4.76	4.70
Graphite carbon	3 06	2.90	0.16	2.42	2.68	2.90	0.20	2.67	0.00	3.16	0.03
Combined carbon	.88	1.20	3.90	1.98	1.62	1.57	4.20	2.01	4.62	1.60	4.67
Silicon	.82	.75	.75	.63	.68	.66	.63	.57	.56	.59	.57
Sulphur	.02	.03	.03	.04	.035	.04	.04	.045	.046	.048	.044
Manganese	.78	.66	.66	.53	.54	.31	.33	.18	.19	.25	.22
Phosphorus	.232	.248	.240	.274	.285	.237	.254	.254	.250	.27	.266
Specific gravity	7.01	7.30	7.61	7.35	.....	7.40	7.70	7.47	7.76	7.46	7.79

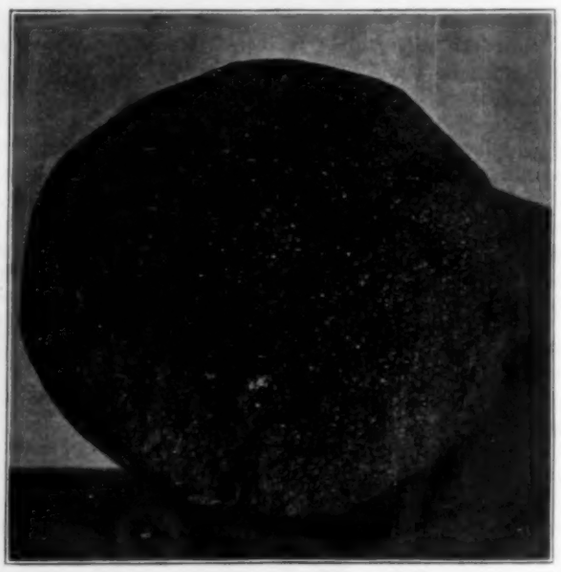

FIG. 1. GREY ROLL.

Combined Carbon, 1.20. Graphitic Carbon, 2.93.

There are several very important features shown by the results in Tables 3 and 4, aside from proving that a chilled iron will melt faster or require less heat than a gray iron of the same composition. Before proceeding to discuss these features, attention is called to the fact that Dr. Moldenke corroborated the results given in Table 3 by testing the comparative fusibility of chilled and gray bodies of the same iron in an open-hearth furnace, which he did with rolls cast from heats Nos. 9 and 11, Table 3.

Figs. 1 and 2 show fractures of gray and chill rolls taken from heat No. 10, and are from photographs taken by Dr. Moldenke as also are those shown in Fig. 3. To emphasize the value of Dr. Moldenke's fusing tests, I would refer to my first paper with his discussion appended, showing just how he makes comparative fusing tests in the open-hearth furnace. It will be well also to mention that the gray or sand rolls which have been used in all these comparative tests were all tumbled so as to get the sand off them thoroughly before they were charged.

Before discussing the results shown by Tables 3 and 4, it will be well first to clearly describe the plan observed in carrying through the eight heats shown.

For heat No. 9, charcoal was charged in both chambers or

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shafts of the cupola and run out of one tap hole, the metal being poured into sand and chilled molds from one ladle. For heat No. 10 the sand and chill rolls from heat No. 9 were charged in their respective sides and the two tap holes used. The melted iron as it ran from this heat through open tap holes

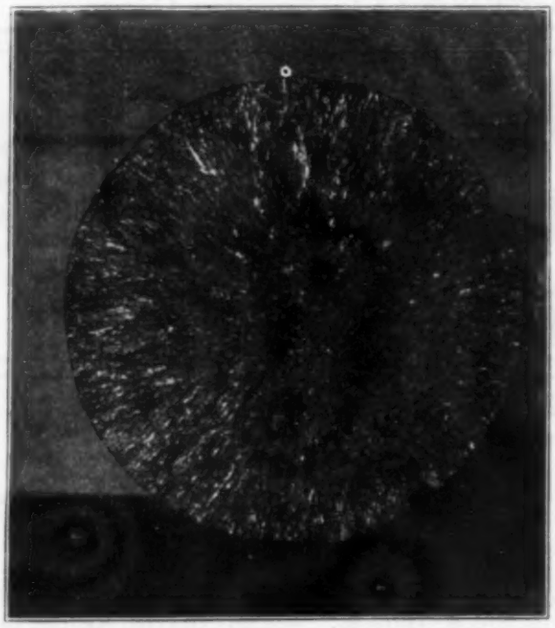

FIG. 2. CHILLED ROLL.

Combined Carbon, 3.90. Graphitic Carbon, 0.16.

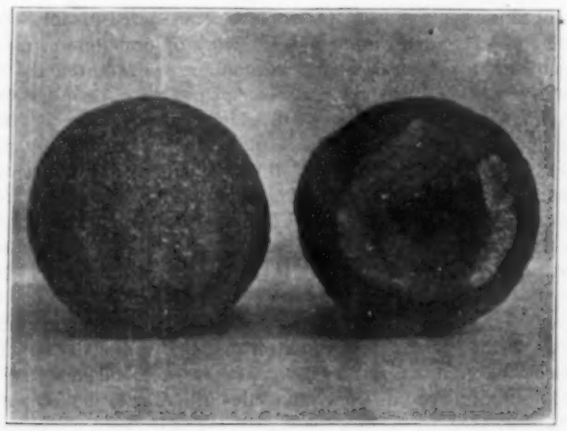

FIG. 3.

GRAY ROLL. CHILLED ROLL.

dropped into sand molds, one being set under each tap hole, to give a block of iron from each side about six inches diameter by six inches high. This tenth heat had both sides run into sand molds, instead of having sand and chill molds used as shown in heats Nos. 9, 11, 13, and 15, for the purpose of learning which would be the harder iron when remelted, that which had been chilled or that which had not. Heat No. 11 melted down the gray blocks obtained from heat No. 10 and this iron was again run into sand and chill molds or roll castings. Heat No. 12 was a remelt of the sand and chill rolls obtained from heat No. 11 and was the fourth and last heat of a continuous remelt of the original charcoal pig used in heat No. 9. Heats 13 and 15 were casts in which the same grade of pig was used as in heat No. 9 as a check to learn if similar results would be obtained by extended experiments, and heats 14 and 16 are used as a check on heats No. 10, in the same manner.

The analyses given under A, B, and C, Table 4, for heats Nos. 9 and 10 will also serve for heats 13 to 16. When running the 16th heat the sand and chill roll metal was run into sand molds the same as described for heat No. 10. Heat No. 17 is a high manganese and phosphorus pig, which was run into sand and chill molds to make rolls that were used for heat No. 18, from which the gray and chilled metals as they came

TABLE 5.—CHEMICAL ANALYSIS OF CHILLED AND GRAY IRON RE-MELTS.

Description of iron and heat No.	Analysis of gray blocks obtained from 10th heat.		Analysis of gray blocks obtained from 16th heat.		Analysis of gray blocks obtained from 18th heat.		Analysis of chilled and sand rolls charged on 20th heat		Analysis of gray blocks obtained from 20th heat.	
Classification of re-melts.	Sand roll re-melt.	Chill roll re-melt.	Sand roll re-melt.	Chill roll re-melt.	Sand roll re-melt.	Chill roll re-melt.	Sand rolls as charged.	Chill rolls as charged.	Sand roll re-melt.	Chill roll re-melt.
Analysis letter.	A2	B2	C2	D2	E2	F2	G2	H2	I2	J2
Total carbon	4.30	4.30	4.30	4.30	2.94	3.15	3.55	3.60	3.88	3.95
Graphite carbon. ...	2.42	2.68	2.20	3.20	2.41	2.73	2.63	2.05	2.15	2.40
Combined carbon ...	1.98	1.62	2.10	1.10	.53	.42	.92	1.55	1.73	1.55
Silicon.	.63	.68	.75	.87	.55	.69	1.55	1.57	1.29	1.39
Sulphur... .	.04	.035	.04	.035	.045	.048	.030	.030	.042	.040
Manganese	.53	.54	.48	.62	1.23	1.32	.133	.135	.126	.130
Phosph'us.	.274	.285	.283	.241	1.07	1.07	.343	.330	.364	.350

down were both run into sand molds to further test the question whether a remelt of chilled iron would not be as soft as the gray iron of the same grade. Heat No. 19 is a No. 2 foundry all coke iron, which was also run into sand and chill molds. Heat No. 20 is made from the sand and chill rolls obtained from the 19th heat, both of which metals were run into sand molds as heats Nos. 10, 16 and 18. Analyses of the gray and chill roll remelts are all shown in Table 5.

Economy and Advantages of Chilled or Sandless Pig Metal.

It has been the general belief heretofore that an iron once chilled would upon being remelted produce a much harder casting than if the same iron had never been chilled. This belief is so strongly maintained by founders that in selecting

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scrap iron for mixtures with pig metal to make light or heavy machinery castings, etc., some will reject the scrap that has been chilled, if it can be done, lest it might cause hard spots in a casting or make the whole too hard. Of course it is to be understood that if a casting shows a chill, it is evidence that the gray body of the casting, if used for scrap, is not accepted as a soft iron, as if no part of the casting exhibited a chill; for, as a rule, founders know such fractures are not to be graded as soft iron. Nevertheless, they do not know, as far as the writer is aware, that instead of a chilled iron body giving a harder remelt, it actually gives the reverse results, so as to make a casting slightly softer by having the chilled scrap used than if it had been rejected and only the gray body utilized. While this knowledge would always have been of much value to the founder, there has been no time that it could be turned to more profitable account than at the present.

There are a few progressive founders that are not aware of methods now used at two Pittsburg furnaces where the casting of pig metal is done in iron chills instead of sand molds. These methods were described in the *Iron Age* and *The Iron Trade Review* recently. Three or four years back such a product of chilled pig metal would be rejected by almost all the foundry trade simply because we then judged pig metal by fracture; and if anyone then even suggested charging pig metal that was chilled, or partially white, thinking thereby to obtain a gray casting, he would be considered insane. But thanks to chemistry and the good work of our foundrymen's associations and co-workers, we now know fractures are deceptive and that the true character of pig metal is only shown by analysis. It may be asked what evidence there is aside from the drilling tests to prove that the chill roll remelt was softer than that of the gray. This is answered by referring to the columns B_2, D_2, F_2 and J_2, Table 5, and noting the greater silicon and graphitic carbon existing in the chill remelt than is found in the gray. The writer's attention was first drawn to the fact that the chill remelt was softer than that of the gray, in drilling to obtain material to make the analyses. The drill worked so much easier in the chill remelt than in the gray as to be a matter of much surprise. To make sure the touch was not deceptive, others were asked to try the drilling, and they all concluded the chill remelt drilled softer than the gray in the first two casts. The drilling test seemed to be very important, as one element in testing the hardness of the iron. We therefore arranged that future tests could have something more reliable from which to record results than the mere sense of touch. The drill press used is of the type worked by a lever to feed the drill. On the lever we affixed a 15-pound weight at a given point which was notched so that the weight would always be placed in the same posi-

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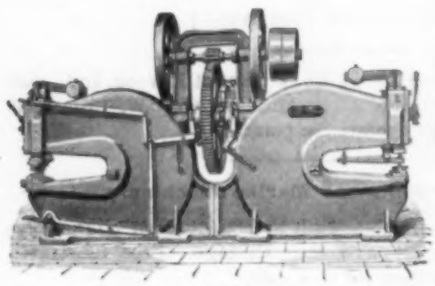

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tion. After a well sharpened twist drill was attached and all ready, the drill was started and allowed to run exactly half a minute. By drilling several holes in this manner, alternately in each of the respective blocks, we could then, by measuring their depth, intelligently tell which of the two was the softer. This process was followed in testing the blocks coming from heats Nos. 18 and 20, which were made partly as checks on the first two heats Nos. 10 and 16. It is to be said that the drillings of the whole four heats Nos. 10, 16, 18 and 20, showed the chill remelt to be softer than those of the gray iron. It will be noticed also that these four remelts are distinct in testing different grades of iron, so as to cover a wide range of metals; from those that would take but a slight chill on the surface of a casting up to those that would chill its whole body as displayed in Fig. 2.

The economy and advantages to be obtained by using chilled pig metal in foundries and in Bessemer steel works may be stated as follows: First, being a harder iron by reason of its chill, or having its carbon largely in the combined form, as well as having the pigs free of sand, less fuel will be needed to melt it, and it can be made to come down faster in the cupola, thus saving time in melting. Second, the pigs being sandless there will be needed less fluxing and slagging of a cupola in large heats and this will also give a cleaner iron out of small as well as large heats from the tap hole. Third, its being chilled will cause it to be broken more easily.

These are the benefits to the founder and steel-maker. The furnaceman is also benefited. There is a considerable saving in making iron, and casting in chills dispenses with the most arduous labor that man can do. Any one watching iron breakers walking over a semi-molten bed of pig metal, breaking it from the sows and then loading it for carriage out of the casting house, to make room for another cast before the metal is cold, will appreciate this. There is nothing that troubles furnace managers more than to find and hold men that will stick to such laborious work, for if a man lasts ten years at it, he is generally of very little value afterwards for other laboring work. Taking all together it is to the interest of all to use chilled cast pig metal, instead of the sand bed pig, as at present.

FIG. 4. WEST'S LIQUID BATH COMPARATIVE FUSION TEST.

Comparative Fusion Testing by Immersion.

Before proceeding further there is one experiment to be described that the writer has designed, and would like to have founders try. At Fig. 4 is seen a three-quarter inch rod in the hands of a molder, being held over a ladle that has fixed to its end a roll casting made in the mold seen at Fig. 5, the upper half S being all green sand held in a wooden box and the lower a chill or iron mold, made in halves and held together

FIG. 5. WEST'S COMPARATIVE FUSION TEST MOLD.

by a ring at T, the whole resting on a bottom block U and the metal being poured in at Q. Now it will be seen readily that a casting made in such a mold would have one-half wholly chilled or body hardened and the other of a softer or more complete gray mixture, which, if held in a bath of molten iron or steel, would be a very pronounced test to assist in showing whether hard or soft grades of iron when charged into a cupola or air furnace as such would melt the faster. The cut seen in Fig. 4 shows a roll having chilled and gray iron ends, that was made in the mold seen at Fig. 5, which was immersed in a crane ladle bath of liquid iron to test which end would go the first. The cut at Fig. 4 shows the exact appearance of the specimen as it was taken out of the crane ladle bath of molten metal, just as the chill end V was about to disappear entirely, and which we have found in all cases to melt away five to ten minutes faster than the gray end X. As the question of encouraging the manufacture of chilled or sandless pig by the blast furnaceman, which this paper is advocating, is an important one, the writer would advise all to try this experiment and in doing it many will find themselves surprised at the rapidity with which the chill or body hardened end melts compared with the gray or soft end of the test specimen. These experiments would further demonstrate the economy in fuel and time in melting to be secured by the use of chilled or sandless pig in the foundry. The design of this method while simple and inexpensive, is very satisfactory and effective. There are many ways in which its use could be applied by metallurgists and founders, to test and demonstrate the comparative fusibility of metals immersed in a bath of liquid iron or steel. In using this device, some judgment will have to be used as to the size of the test roll and ladle for its immersion. For a roll of two to three inches diameter a ten hundred pounds or over ladle will be necessary, but rolls about one inch diameter could often be melted down in a bull ladle holding 200 to 300 lbs. of iron before the metal would get too dull. These rolls are well made about 12 inches long and are secured by the end of the rod seen curved around it tightly in the center. All sand and scale should be well filed or ground off from the sand end of the roll so as to have it free from foreign matter, the same as in the chilled or hardened end, to make conditions alike in each end as far as possible.

[CONCLUDED NEXT WEEK.]

THE Akron Steam Forge Co.'s plant at Elwood, Ind., was sold Oct. 14 to Col. Geo. T. Perkins and Geo. W. Crouse, of Akron, O., who will operate the plant.

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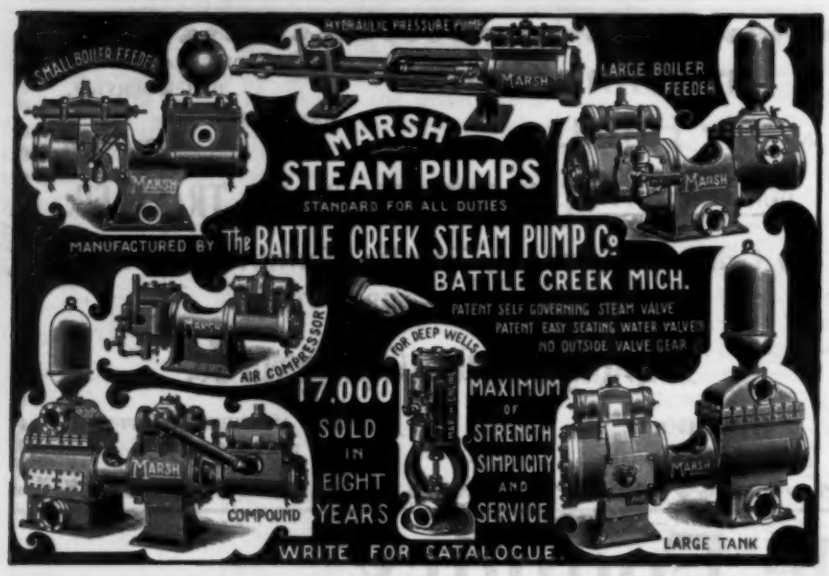

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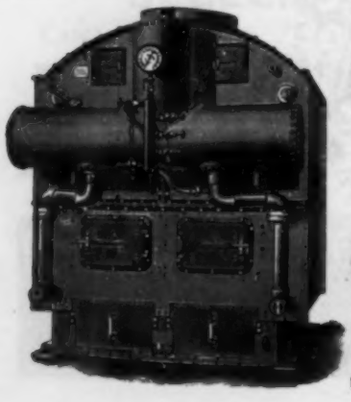

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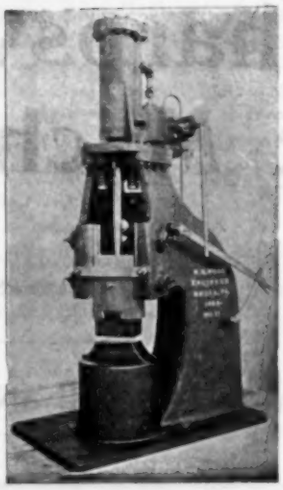

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Salem and Pittsburg	* 8:00 am	* 8:30 pm
Pittsburgh, Bellaire and East	‡ 3:15 pm	† 6:25 pm
Philadelphia and New York	* 1:40 pm	*11:25 am
Baltimore and Washington	* 1:40 pm	*11:25 am
Alliance and Pittsburgh	* 1:40 pm	*11:25 am
Ravenna and Alliance	* 5:00 pm	* 8:40 am
Philadelphia and New York	*11:10 pm	* 4:30 am
Baltimore and Washington	*11:10 pm	* 4:30 am
Alliance and Pittsburgh	*11:10 pm	* 4:30 am

Mt. Vernon and Pan-Handle Route

FROM CLEVELAND TO	LEAVE	ARRIVE
Xenia and Cincinnati	* 8:50 am	* 5:30 pm
Akron and Columbus	* 8:50 am	* 5:30 pm
Akron and Columbus	† 1:40 pm	†12:10 pm
Col. Cin. Ind. & St. L.	‡ 8:00 pm	* 7:30 am
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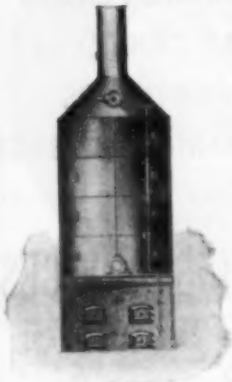

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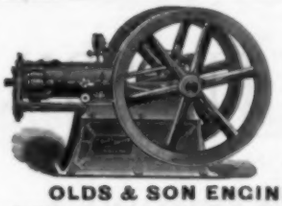

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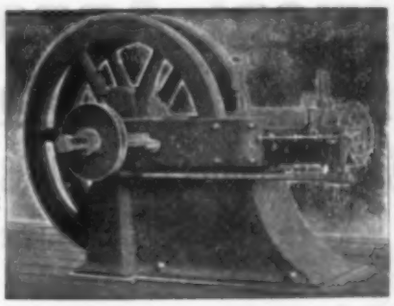

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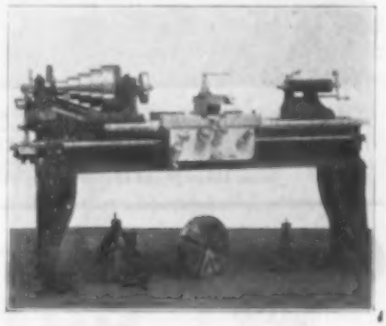

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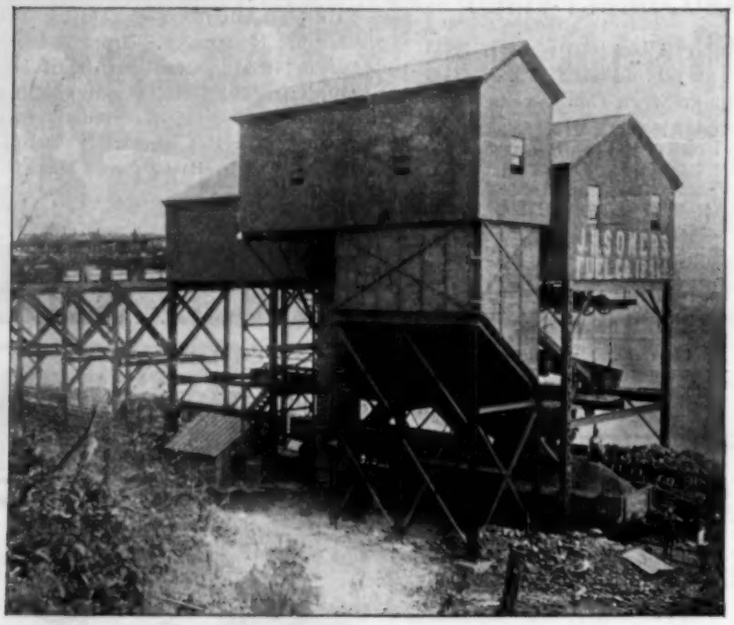

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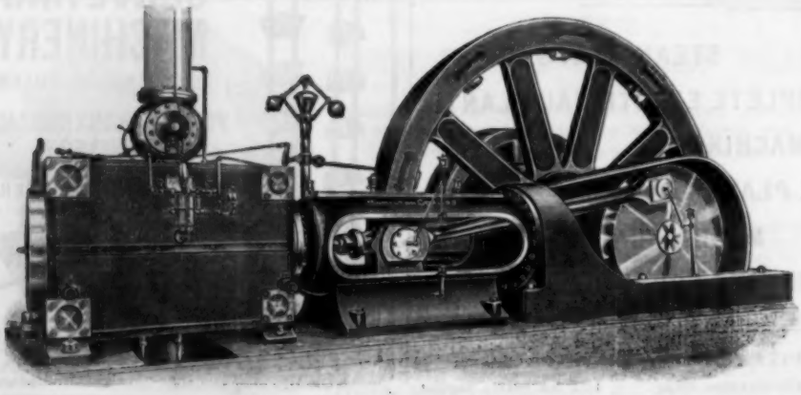

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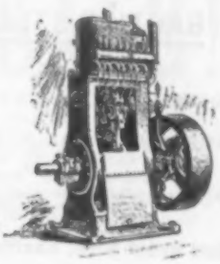

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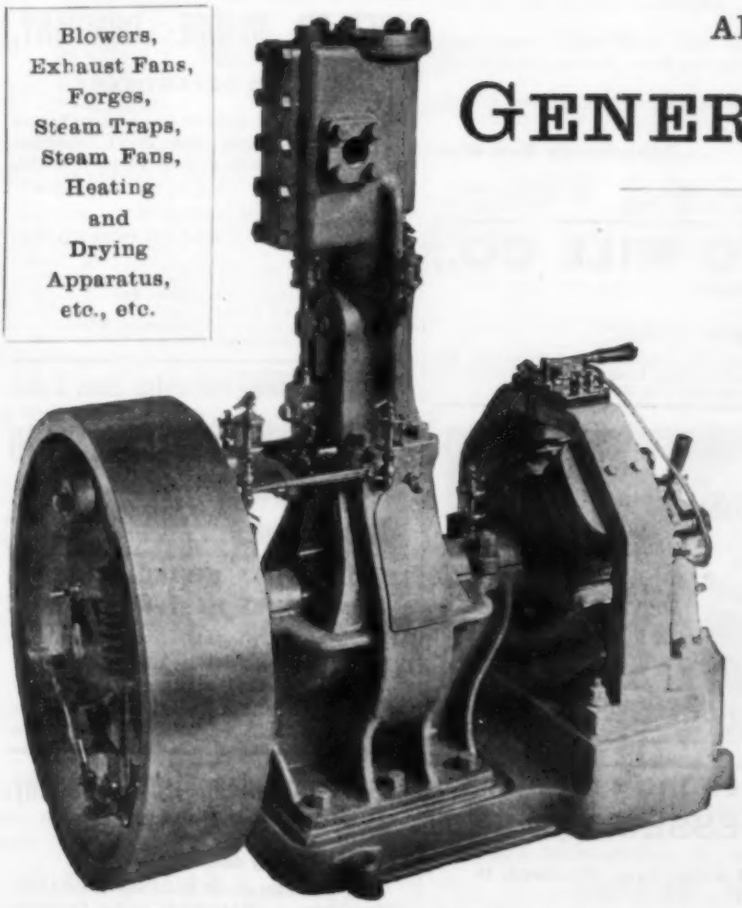

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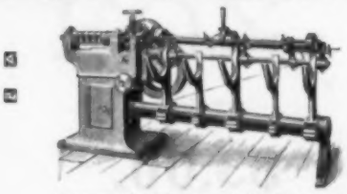

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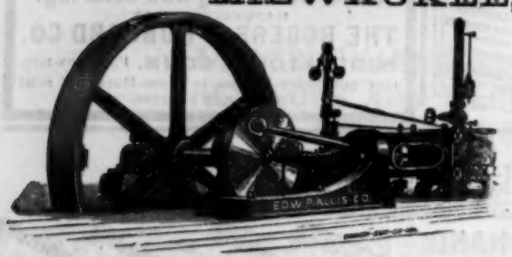

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The star (*) indicates that the adv. appears alternate weeks; the dagger (†) once a month; the double dagger (‡) once in three weeks; the parallel (‖) three times out of four.

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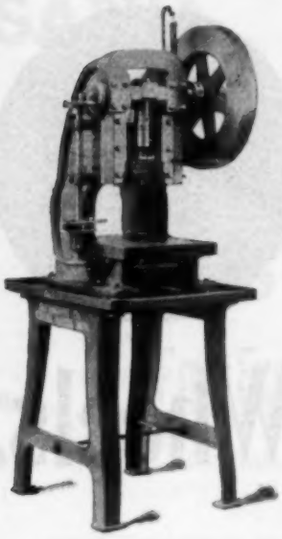

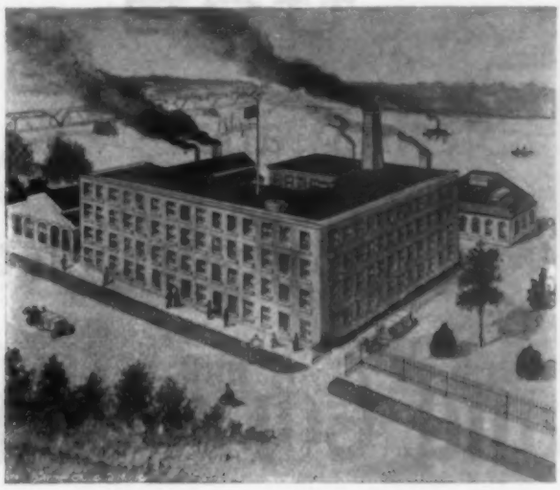

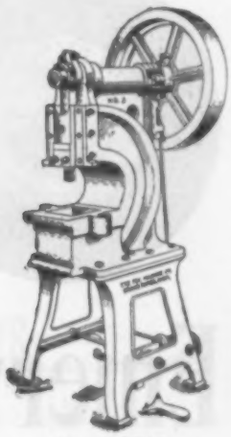

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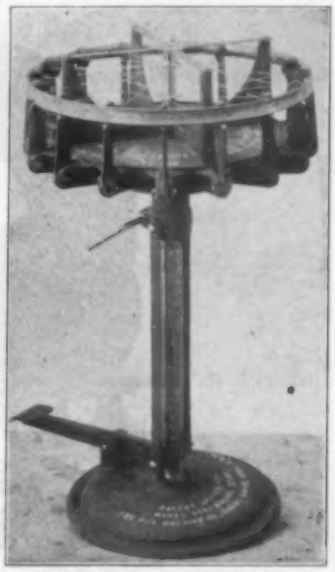

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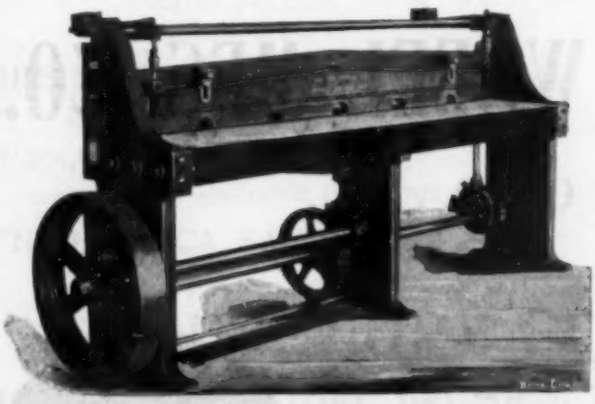

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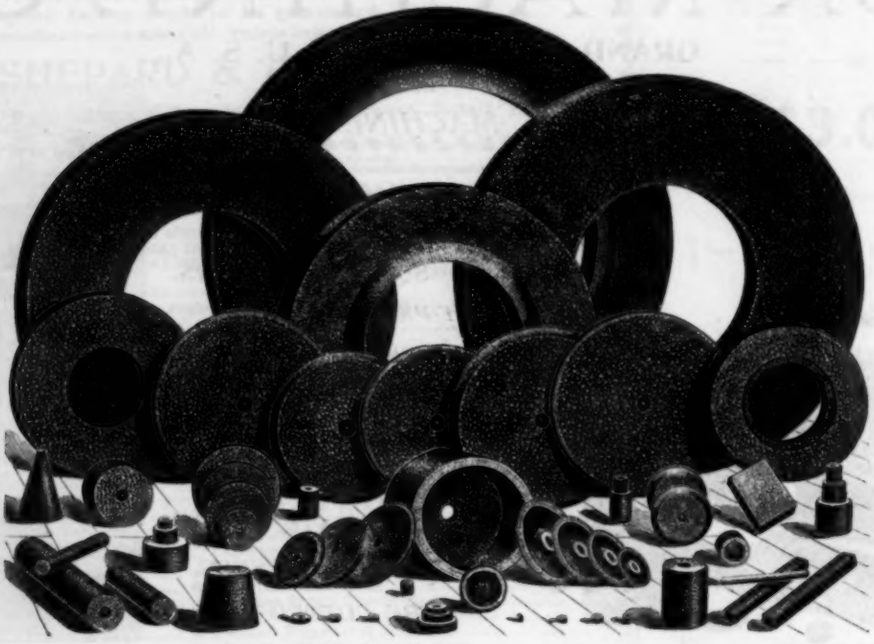

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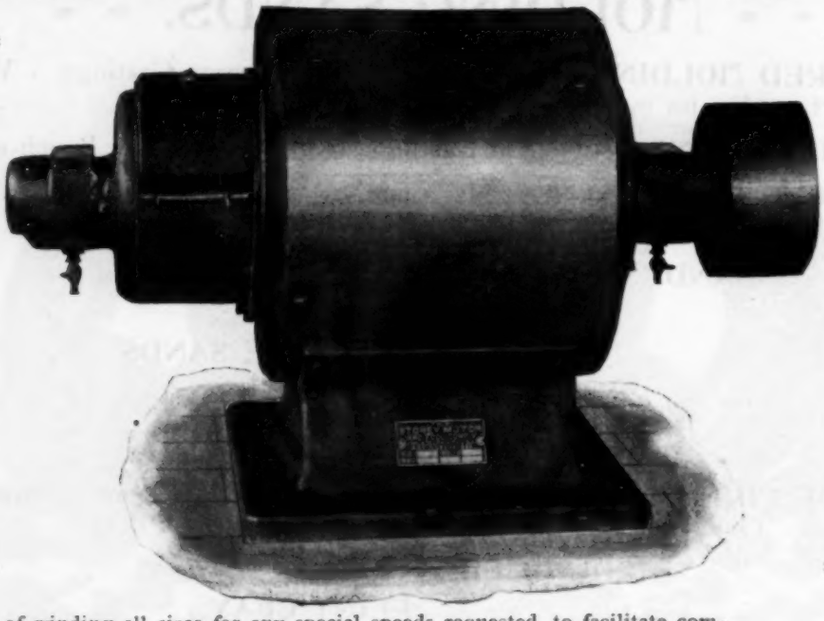

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Eave Troughs and Conductors—
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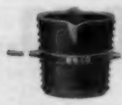

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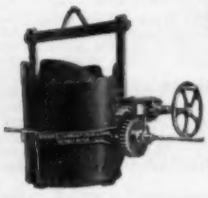

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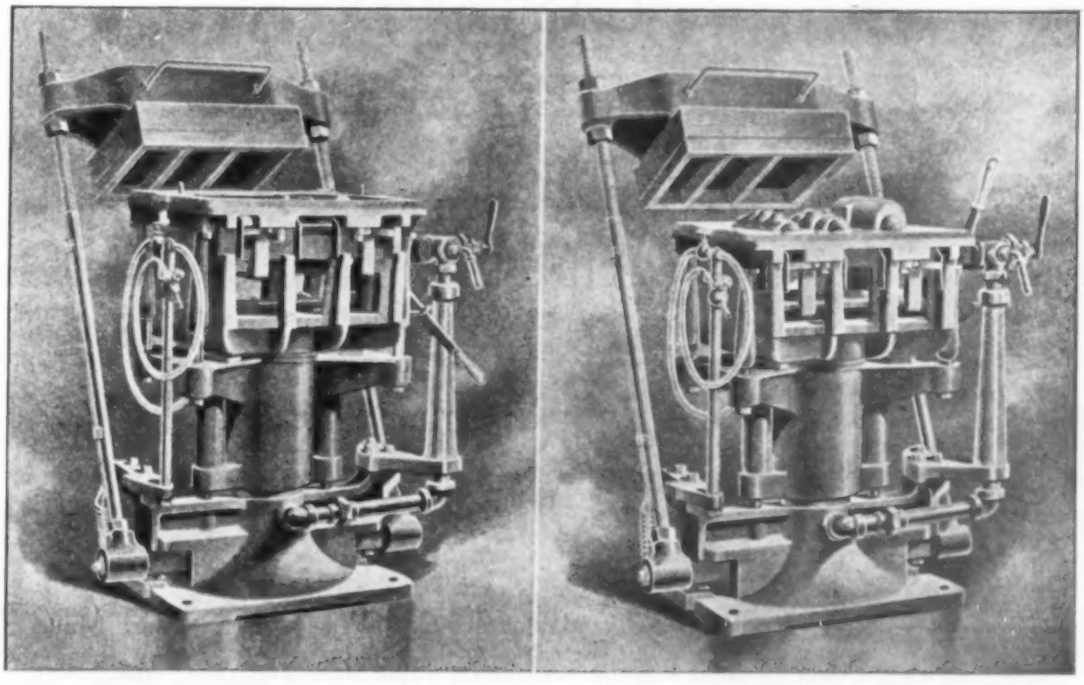

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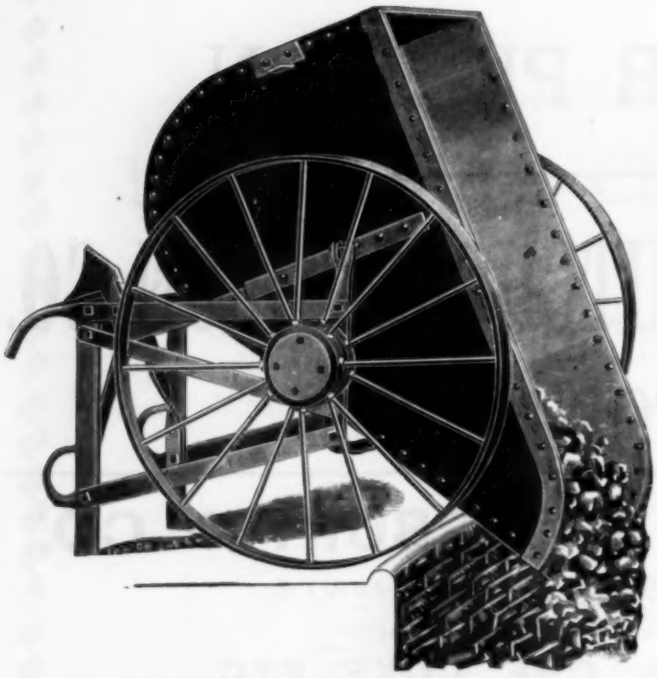

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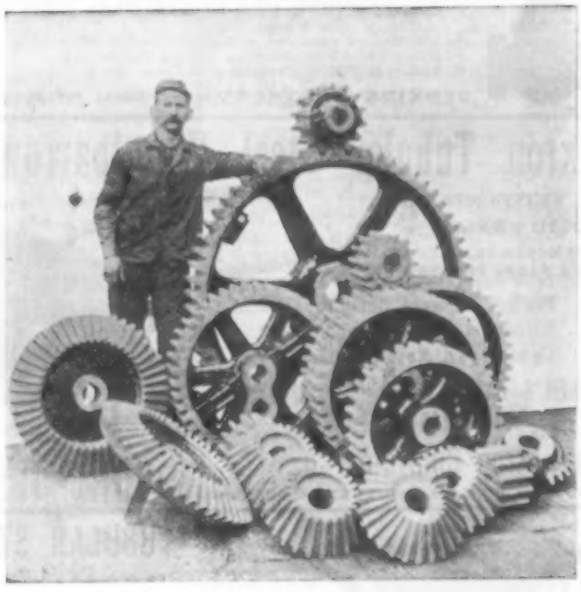

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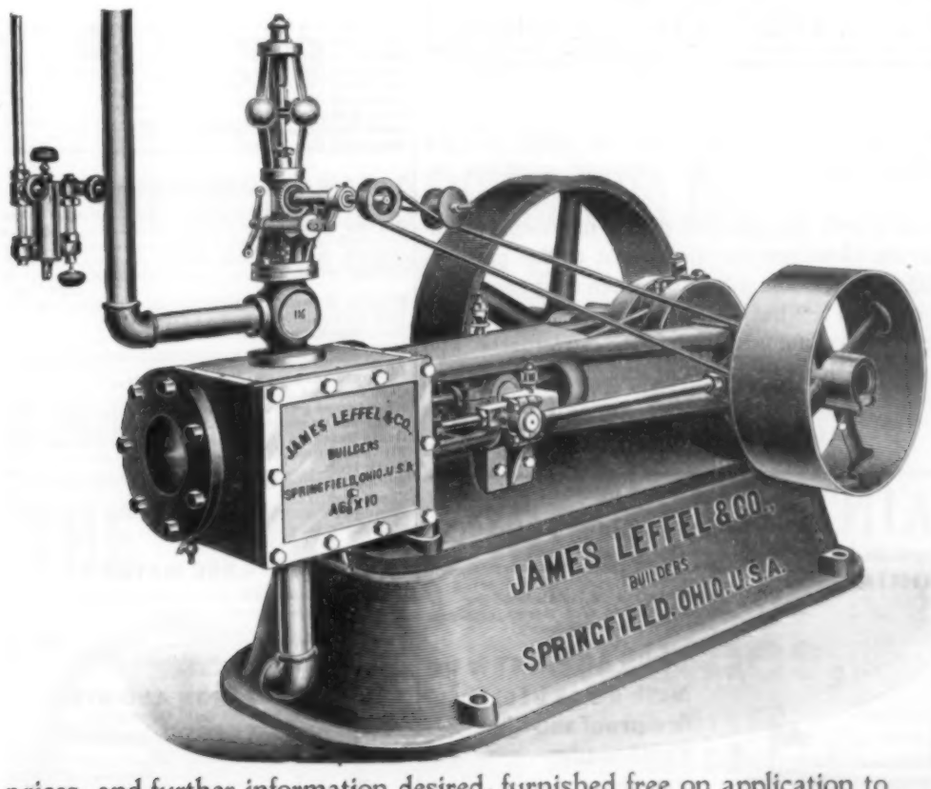


(shown herewith) is a new design in which is embodied latest improvements and best practice in modern Steam Engine Construction. It is quite simple, easily understood and run. All parts are extra strong and stiff, rendering it specially durable for long and severe service, thus reducing repair bills to a minimum. Furnished with or without a Boiler, in various sizes and styles. New pamphlet "D" fully illustrating and describing this and other Engines and Boilers, with prices, and further information desired, furnished free on application to

JAMES LEFFEL & CO., Springfield, Ohio.

PERFORATED METALS

OF ALL KINDS FOR

MILLING, MINING AND AGRICULTURAL MACHINERY.

Perforated Iron, Steel, Copper, Brass, Tin, Zinc, Lead, Etc., to Order.
Large and Varied Assortment of Sizes. Correspondence Solicited.

THE ROBERT AITCHISON PERFORATED METAL CO.,

Office, Room 510, 265 to 269 Dearborn St., CHICAGO, ILL. Works, So. Chicago.

We Claim The Following Merits for Jenkins Bros.' Valves

1. Manufactured of the best Steam Metal.
2. No regrinding, therefore not constantly wearing out the Seat of the Valves.
3. Contain JENKINS DISC, which is suitable for all Pressures of Steam, Oil and Acids
4. The Easiest Repaired, and all parts Interchangeable.
5. Every Valve Tested before leaving the factory. (2)
6. ALL GENUINE stamped with Trade Mark,

JENKINS BROTHERS, NEW YORK, PHILADELPHIA, CHICAGO, BOSTON.

Akron Tubular Steel Wheelbarrows.

RE-INFORCED TRAYS.
SOLID FRAME.
NO HOLES DRILLED INTO IT
ALL PARTS CLAMPED ON.

Perfect Forward Dump.
Strongest, Easiest Handled.
Lightest and Most Durable.

McNEIL'S PATENT BALANCED AUTOMATIC DUMP CHARGING BARROW.

The Akron Cultivator Co.,
MANUFACTURERS, Akron, Ohio.

TUBULAR STEEL BARROWS.

Special hand-made pig iron barrows.

WHEELBARROW CARS AND TRUCKS

WRITE FOR CATALOGUE.

LANSING WHEELBARROW CO.,
Lansing, Mich.

Don't Waste Money in Your Pattern Shop.
THE GOBEILLE PATTERN CO., Cleveland.

Not every insertion of every advertiser's card brings an order for the advertiser's good; no more does every visit of the traveling salesman result in a sale.

There is a vast deal in familiarity with the type and phrase in which a manufacturer makes himself known to the advertisement reader, just as the personal acquaintance of his traveling salesman gets him a hearing when a strange face and a strange voice are bowed out with a "busy day's" courtesies.

The best advertisers, the most successful advertisers, the advertisers who get returns, are those who keep everlastingly at it.

This is a case in which familiarity breeds business.

IRON CLAD PAINT CO.

Factory, 75 & 77 Central Way. Sec. & Treas., No. 3 Case Build'g.
CLEVELAND OHIO.

ORDER DIRECT FROM THE
Iron Clad Paint Co.

And get the genuine article, and save liability of suit for using an article made in violation of the patents issued to Wm. Green, and now owned by this Company.

IRON CLAD PAINT is the most durable, most fire-proof and Cheapest Paint made.

FURNISHED both Dry and Ground in Oil

USED BY NEARLY ALL THE RAILROADS.

IRON AND STEEL MARKETS.

IRON ORE.

[On Lake Erie docks.]

Special low-phosphorus hard Ore, Bessemer	$3.40@3.46
No. 1 Specular, Besemer	3.05@3.17
No. 1 Bessemer hematite	2.60@2.90
Hematites No. 1 non-Bessemer	2.00@2.25
No 1. Specular, non-Bessemer	2.40@2.60

PIG IRON.

CLEVELAND (f. o. b. cars):	
Bessemer	$10 50@10 75
No. 1 Strong Foundry	10 65@10 75
No. 2 Strong Foundry	10 15@10 25
No. 1 Gray Forge, red short	9 75
No. 2 Gray Forge, neutral	9 90
No. 1 American Scotch	10 65@10 90
No. 2 American Scotch	10 15@10 40
Lake Superior Charcoal	12 25@12 50
PITTSBURG:	
No. 1 Foundry	$11 00@11 25
No. 2 Foundry	10 65@10 90
Gray Forge	9 75@10 00
White and Mottled	9 50
Warm Blast Charcoal	13 00@13 50
Cold Blast Charcoal	16 00
Bessemer	9 90@10 10
CHICAGO:	
Lake Superior Charcoal	$12 50@$13 00
Local Coke Foundry No. 1	11 50@12 00
Local Coke Foundry No. 2	11 00@11 50
Local Coke Foundry No. 3	10 50@11 00
Local Scotch Foundry No. 1	11 50@12 00
Local Scotch Foundry No. 2	11 00@11 50
Local Scotch Foundry No. 3	10 50@11 00
Southern Coke No. 1	11 00@11 25
Southern Coke No. 2	10 60@10 85
Southern Coke No. 3	10 35@10 60
Southern No. 1 Soft	11 00@11 25
Southern No. 2 Soft	10 60@10 85
Southern Silveries	11 25@11 50
Jackson Co. Silveries	12 50@14 30
Ohio Silveries No. 1	@
Ohio Strong Softeners	12 00@12 25
Alabama Car Wheel	16 00@17 00
Malleable Bessemer	10 75@11 00
Coke Bessemer	11 50@12 00
CINCINNATI (reported by Rogers, Brown & Co.)	
Southern Coke No. 1, Foundry	$ 10 00
Southern Coke No. 2 and No. 1 Soft	9 50@10 00
Hanging Rock Coke, No 1	12 50@13 50
Hanging Rock Charcoal No. 1, Fdy	14 50@15 50
Tennessee Charcoal No 1	12 50@13 00
Jackson County Silvery No 1	12 50@13 00
Southern Coke, Gray Forge	8 25@8 50
" " Mottled	8 25@8 50
Standard Georgia Car Wheel	14 25@15 00
Tennessee " "	13 00@14 00
Lake Superior " "	14 75@15 25
BUFFALO:	
No. 1 Foundry Strong Coke Iron Lake Superior Ore	11 25
No. 2 Foundry Strong Coke Iron Lake Superior Ore	10 75
Ohio Strong Softener No. 1	11 75
Jackson Co. Silvery No. 1	14 00
Lake Superior Charcoal	15 50
Southern Soft No. 1	11 75
Hanging Rock Charcoal	17 00
ST. LOUIS:	
Southern Coke No 1	$ 9 50@$ 9 75
Southern Coke No. 2	9 00@9 25
Southern Coke No. 3	8 50@8 75
Southern Gray Forge	8 00@8 25
Southern Charcoal No. 1	13 00
Missouri Bessemer	12 00
Ohio Softeners	13 50
Lake Superior Car Wheel	14 50
Southern Car Wheel	14 50

OLD RAILS AND SCRAP METAL.

[Delivered Cleveland.]	Gross Tons
Old iron rails	$14 00
Old steel rails (6 ft. and over)	10 50
Old steel rails (6 ft. and under)	10 00
Old car wheels	11 00
	Net Tons
No. 1 R. R. wrought scrap	$11 50
Mill scrap	8 50
No. 1 Machine cast scrap	8 00
Iron axles	15 00
Axle turnings	8 00
Wrought turnings (free from cast)	6 50
Cast borings	5 25
Uncut wrought iron boilers	3 50
Steel boiler plates	8 00
Grate bars	5 25
Pipes and flues (clean)	7 50
Tank iron	7 00
Hoop and band iron	6 50
Sheet iron	5 00
Wrought drillings	6 00
Malleable iron	8 50

STRUCTURAL MATERIAL.

Beams and Channels (f. o. b. Cleveland)	1.15c
Angles	1.15c
Tees	1.25c
Universal Plates	1.15@1.20c
Sheared Plates	1.20c

MERCHANT IRON AND STEEL.

[Less than car-lots, Cleveland.]

Rounds and Squares.—Bar Iron.

1 to 1⅞	1.10 Base.
2 to 2⅞	.20 extra.
3 to 3½	.50 "
3⅝ to 4	.80 "
4⅛ to 4½	1.00 "
4⅝ to 5	1.30 "
5⅛ to 6	1.80 "
6¼ to 6½	2.20 "

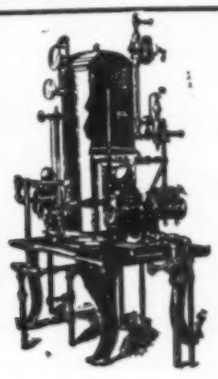
The Link-Belt Machinery Co.

ENGINEERS. FOUNDERS. MACHINISTS.

CHICAGO, U. S. A.

Modern Methods as applied to the handling of Iron Ore, Coal, Raw and Manufactured Products.

Manila Rope, Power Transmissions, Shafting, Pulleys, Shaft Bearings, Gearing Friction Clutches, etc.



IMPROVED DUPLEX SYSTEM

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BURNING FUEL OIL.

Heats and cleans the oil and delivers it to the fires under high and uniform pressure.

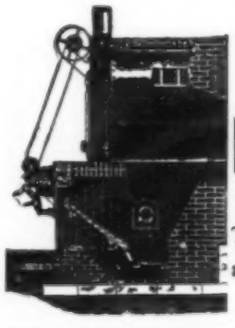
Entirely automatic, most scientific, sensible and economical method of burning oil in existence. If you are operating a Steel Works, Brass or Copper Rolling Mill, Malleable Iron Works, Bolt and Nut Works, Bicycle Works, or do Annealing, Forging, Brazing, Tempering, Japanning, Enameling, Case Hardening, you can use this machine to your advantage.

WE BUILD FURNACES OF ALL KINDS. SATISFACTION GUARANTEED.

W. S. ROCKWELL & CO.,

26 CORTLANDT STREET, NEW YORK.

H. H. CAMPBELL.



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648 Broadway, CLEVELAND, O.

SOLE MANUFACTURERS OF THE

Brightman Mechanical Stoker

FOR STEAM BOILERS.

THE MOST ECONOMICAL IN FUEL

and the Best Device in the World for Preventing Smoke.

Send for Catalogue "A."

STUART FIRE BRICK CO.

MANUFACTURERS OF

Silica Brick

For Open-Hearth, Basic and Acid Steel Furnaces, Glass and Copper Tank Furnaces. Extra Shapes MADE TO ORDER.

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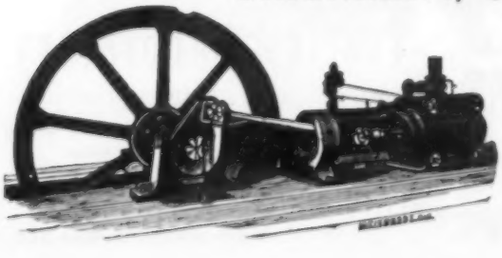
JACKSON, O.

Producers of SILICA, FIRE and CORE SAND. Also MOLDING SAND for STEEL CASTINGS. Write for Prices.

Subscribe for the Iron Trade Review, $3 per year.

THE LANE & BODLEY CO.,

CINCINNATI, OHIO.



Engines,

ALL SIZES.

Simple and Compound.

Shafting, Hangers, Pulleys.

Belt, Elevators, Saw Mills.

6⅝ to 7¾	2.50 extra.
¾ to ⅞	.10 "
⅞ to 11-16	.20 "
½ to 9-16	.30 "
7-16 to 15-32	.40 "
⅜ to 13-32	.50 "
5-16 to 11-32	.70 "
¼ to 9-32	.90 "
7-32	1.40 "
3-16	2.50 "

Flats.—Bar Iron.

1⅛ to 4 x ⅜ to 1	1.05 Base.
4¼ to 6 x ⅜ to 1	.10 extra
6¼ to 8 x ⅜ to 1	.60 "
8¼ to 10 x ⅜ to 1	.80 "
1⅛ to 4 x 1 1-16 to 1⅜	.30 "
4¼ to 6 x 1 1-16 to 1⅜	.40 "
6¼ to 8 x 1 1-16 to 1⅜	.60 "
8¼ to 10 x 1 1-16 to 1⅜	.90 "
2 to 4 x 1⅜ to 2	.50 "
4¼ to 6 x 1⅜ to 2	.60 "
6¼ to 8 x 1⅜ to 2	.80 "
8¼ to 10 x 1⅜ to 2	1.00 "
2 to 4 x 2⅛ to 3	.60 "
4¼ to 6 x 2⅛ to 3	.80 "
6¼ to 8 x 2⅛ to 3	1.00 "
1⅛ to 1¼ x ⅜ to 1	.10 "
1 to 1 1-16 x ⅜ to ⅞	.20 "
¼ to 15-16 x ⅜ to ¾	.40 "
⅜ to 11-16 x ⅜ to ⅞	.50 "
½ to 9-16 x ⅜ to ⅝	.90 "

Heavy Band Iron.

7 to 10 x ¼ to 5-16	.70 extra.
6¼ to 6¾ x ¼ to 5-16	.50 "
4¼ to 6 x ¼ to 5-16	.30 "
1⅛ to 4 x ¼ to 5-16	.20 "
1 to 1⅜ x ¼ to 5-16	.30 "
¼ to 15-16 x ¼ to 5-16	.50 "
⅜ to 11-16 x ¼ to 5-16	.80 "
½ to 9-16 x ¼ to 5-16	1.00 "
⅝ to 7-16 x ¼ to 5-16	1.50 "

Heavy bands, 7-32 in. thick 1 10 c. per lb. higher than ¼ to 5 16 thick. **Bevel Edge Shaft Iron** 1-10 higher than same size of Heavy Bands.

Light Band Iron.

7 to 8 x No. 9 to 3-16	.90 extra.
7 to 8 x Nos. 10, 11 and 12	1.00 "
6¼ to 6¾ x No. 9 to 3-16	.70 "
6¼ to 6¾ x Nos. 10, 11 and 12	.80 "
4¼ to 6 x No. 9 to 3-16	.50 "
4¼ to 6 x Nos. 10, 11 and 12	.60 "
1⅛ to 4 x No. 9 to 3-16	.40 "
1⅛ to 4 x Nos. 10, 11 and 12	.50 "
1 to 1 3-16 x No. 9 to 3-16	.50 "
1 to 1 3-16 x Nos. 10, 11 and 12	.60 "
13-16 to ⅞ x No. 9 to 3-16	.60 "
13-16 to ⅞ x Nos. 10, 11 and 12	.70 "
11-16 to ¾ x No. 9 to 3-16	.80 "
11-16 to ¾ x Nos. 10, 11 and 12	.90 "
9-16 to ⅝ x No. 9 to 3-16	1.00 "
9-16 to ⅝ x Nos 10, 11 and 12	1.10 "
7-16 to ½ x No. 9 to 3-16	1.30 "
7-16 to ½ x Nos. 10, 11 and 12	1 40
⅜ x No. 9 to 3-16	1.50
⅜ x Nos. 10, 11 and 12	1.60

Bevel Edge Box Iron.

Same as Light Bands, of same sizes.

Beaded Band Iron, 1¼ in. to 2 in.

Sand Band Iron, 1-10 c. above same sizes of Light Bands.

Oval Iron.

⅞ to 1⅜	.40 extra.
¾ to 13-16	.50 "
⅝ to 11-16	.60 "
½ to 9-16	.80 "
⅜ to 7-16	1.10 "
⅛ to 9-16 x 3-16	1.00 "
⅜ to 11-16 x ⅛	1.20 "

Half Oval and Half Round.

2¼ to 3	.60 extra.
⅞ to 2	.50 "
¼ to 13-16	.70 "
⅝ to 11-16	90 "
⅛ to 9-16	1.20 "
⅜ to 7-16	2.50 "
5-16	3.50 "
¼	4 50 "

Half Ovals less than ¾ their width in thickness, extra price.

Horse Shoe Iron.

All sizes .1 c. extra.

Cutting ordinary bars to specified length, .20 to .30 extra, according to length and size.

Steel Bands.

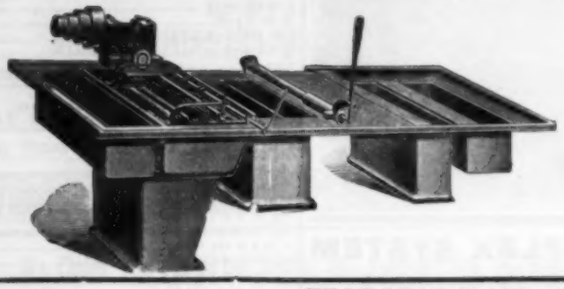
Width In Inches.	English Standard Gauge.		
1 1-2 to 6,	Nos. 7, 8, 9 or 3-16 "	1.50 Base.	
		Extras.	
1¼ to 6,	" 10, 11, 12 or 5/64"	.05 per 100 lbs.	
1 to 1¾,	" 7, 8, 9 or 3-16"	.10	"
1 to 1¾,	" 10, 11, 12 or 5/64"	.15	"
13-16 and ⅞,	" 7, 8, 9 or 3-16"	.20	"
13-16 and ⅞,	" 10, 11, 12 or 5/64"	.25	"
11-16 and ¾,	" 7, 8, 9 or 3-16"	.30	"
11-16 and ¾,	" 10 11, 12 or 5/64"	.35	"
9-16 and ⅝,	" 7, 8, 9 or 3-16"	.40	"
9-16 and ⅝,	" 10 11, 12 or 5/64"	.45	"
½, Nos. 7, 8, 9 or 3-16"		.55	"
½, " 10, 11, 12 or 5/64"		.60	"
7-16 " 7, 8, 9 or 3-16"		.75	"
7-19 " 10, 11, 12 or 5/64"		.85	"
⅜, " 7, 8, 9 or 3-16"		.95	"
⅜, " 10, 11, 12 or 5/64"		1.05	"

Iron and Steel Hoops.

Width in Inches.	English Standard Gauge.		
1 7-16 to 3	Nos. 13, 14, 15 and 16	1.60 Base.	
		Extras	
1 7-16 to 2,	" 17, 18, and 19	.05 per 100 lbs.	
1 7-16 to 2,	" 20	.10	"
1 7-16 to 2,	" 21	.15	
1 7-16 to 1¾,	" 22	.25	
1 ⅜ to 1⅜,	" 13, 14 and 15	.05	
1⅜ to 1⅜,	" 16, 17, and 18	10	

THE LLOYD BOOTH CO., YOUNGSTOWN, OHIO.

Tinning MACHINERY.



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We are the only Steel Roofing Co. awarded Medal and Diploma for PATENT CAP ROOFING at World's Columbian Exposition. We are also large manufacturers of all styles of METAL ROOFING, SIDING, CEILING, ETC. Send for Catalogue and Price List. Mention this paper.

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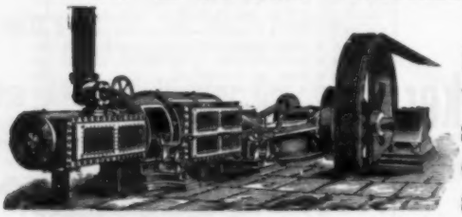
WILLIAM TOD & CO.

YOUNGSTOWN, OHIO.

The Porter-Hamilton Engine



Reversing Engines, Blowing Engines, Converters, Hydraulic and special heavy machinery for the iron and steel trades.

Williams Improved Vertical Engines

For Direct Electrical and all High Class Work.

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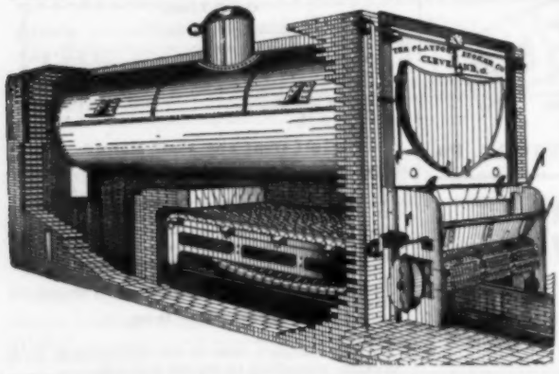
E. F. WILLIAMS.

Park Building, Pittsburg,
SEWARD S. BABBITT.



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Guaranteed to

Abolish smoke, to increase boiler capacity and to save fuel.

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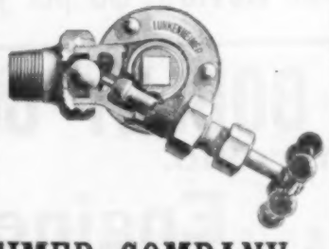
The Playford Stoker Co.,

No. 61 Case Library Bldg.,

CLEVELAND, O.

Lunkenheimer's Automatic Water Gauge

will be found all that its name implies, and can be relied upon to act promptly in shutting off water from gauges when glass breaks, thus the danger and annoyance attendant upon closing of valves attached to gauges is dispensed with. Made of gun metal, tested, highly finished, thoroughly reliable and warranted first class. Special circular and catalogue upon request.



THE LUNKENHEIMER COMPANY,

Cincinnati, Ohio, U. S. A.

SOLE MANUFACTURERS.

26 Cortlandt Street, NEW YORK. } BRANCHES: { 35 Great Dover treet, LONDON, S. E.

1⅛ to 1⅜,	"	19 and 20	.15 per 100 lbs.
1⅛ to 1⅜,	"	21	.20 "
1⅛ to 1⅜,	"	22	.30 "
15-16 and 1,	"	13, 14 and 15	.10 "
15-16 and 1,	"	16, 17 and 18	.15 "
15-16 and 1,	"	19 and 20	.20 "
15-16 and 1,	"	21	.25 "
15-16 and 1,	"	22	.35 "
⅞, Nos. 13, 14 and 15			.20 "
⅞, " 16, 17 and 18			.25 "
⅞, " 19 and 20			.30 "
⅞, " 21			.35 "
⅞, " 22			.45 "
¾ and 13-16 Nos. 13, 14 and 15			.30 "
¾ and 13-16 " 16, 17 and 18			.35 "
¾ and 13-16 " 19 and 20			.40 "
¾ and 13-16 " 21			.45 "
¾ and 13-16 " 22			.50 "
¾ and 13-16 " 23			.60 "
11-16, Nos. 13, 14 and 15			.35 "
11-16, " 16, 17 and 18			.40 "
11-16, " 19 and 20			.50 "
11-16, " 21			.60 "
11-16, " 22			.70 "
11-16, " 23			.80 "
⅝, Nos. 13, 14 and 15			.40 "
⅝, " 16, 17 and 18			.45 "
⅝, " 19 and 20			.55 "
⅝, " 21			.65 "
⅝, " 22			.75 "
⅝, " 23			.85 "
9-16, " 13, 14 and 15			.45 "
9-16, " 16, 17 and 18			.50 "
9-16, " 19 and 20			.60 "
9-16, " 21			.70 "
9-16, " 22			.80 "
9-16, " 23			.90 "
½, " 13, 14 and 15			.55 "
½, " 16, 17 and 18			.60 "
½, " 19 and 20			.70 "
½, " 21			.80 "
½, " 22			.90 "
½, " 23			1.00 "
7-16, " 13, 14 and 15			.80 "
7-16, " 16, 17 and 18			.90 "
7-16, " 19 and 20			1.00 "
⅜, " 13, 14 and 15			1.00 "
⅜, " 16, 17 and 18			1.10 "
⅜, " 19 and 20			1.20 "

Sheet Iron.

No. 10	1 50
No. 12	1 70
No. 14	1 60
No. 15-17	1 75
No. 18	1 85
No. 20	2 00
No. 22-24	2
No. 25-26	2 20
No. 27	2 30

English Tool Steel.

Jessop's	15½c
Hobson's "Best"	13½c
" "Choice"	35c

Steel Boiler Plates—1-4 in. and Heavier.

Tank	1 35
Shell	1 45
Flange	1 55
Marine Flange	1 60
Fire Box	2 05

Above includes plates 90 inches wide.

90 to 96 in. wide	½c. lb. extra
96 to 100 in. wide	1c. "
100 to 104 in. wide	1½c. "
104 to 106 in. wide	special.

Flats.	cts. lbs.
2 to 9-16 in. wide by 2 to ⅜ thick	.08

Bessemer and O. H. Steel.

Bessemer Machinery	base price,	1 40
Open-hearth Tire	"	1 45
Open-hearth Spring	"	1 80
Sleigh Shoe	"	1 45
Toe Calk	"	1 90
Cutter Shoes, tapered and bent	"	1 60

American Cast Tool Steel.

ROUND, SQUARE, AND OCTAGON.	cts. lbs.
1 to 2 in. inclusive	.08
9-16 to ½ in. "	.08
7-16 to ⅜ and 2⅜ to 3 in	.09
3⅜ to 4 in	.09½
⅝ to 11-16 and 4⅛	.10
⅛ to 6 in	.10½
¾ to 9-32 and 6⅛ to 7 in	.11
1 in	.13

Burden Boiler Rivets.

½, ⅝, 11-16 and ¾ inches diameter	3 60
Bridge ½, ⅝, 11-16 and ¾ inch diam	2 55

Wrought Pipe and Boiler Tubes.

Lap weld black, base, and 10 per cent	.78
Butt " " " "	.72
Lap " galv. " "	.70
Butt " " " "	.67
Boiler tubes 2¼" and smaller	.72½
Boiler tubes 2½" and larger	.75
Casting screw and socket joint	dis. 50
Casing inserted joint	dis. 45

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All Kinds of Chemical Work. Reports on Mining Property and Technical Processes.

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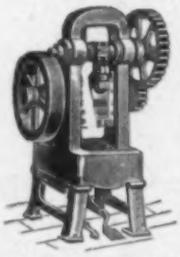

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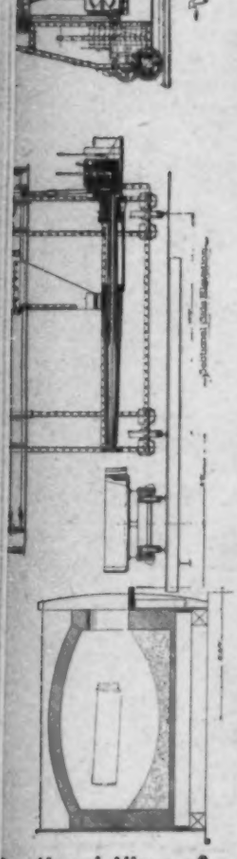

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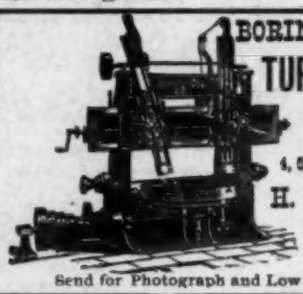

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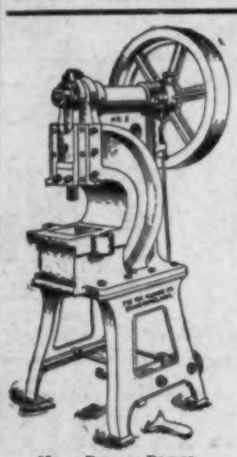

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